DOCUMENT RESUME

ED 440 975 SP 039 213

| | |
|---|---|
| AUTHOR | Chambers, Jack A., Ed. |
| TITLE | Selected Papers from the 11th International Conference on College Teaching and Learning (11th, Jacksonville, Florida, April 12-15, 2000). |
| INSTITUTION | Florida Community Coll., Jacksonville. Center for the Advancement of Teaching and Learning |
| PUB DATE | 2000-00-00 |
| NOTE | 185p. |
| AVAILABLE FROM | Center for the Advancement of Teaching and Learning, Florida Community College at Jacksonville, 501 West State Street, Room 102, Jacksonville, FL 32202 ($15). |
| PUB TYPE | Collected Works - General (020) |
| EDRS PRICE | EDRS Price MF01 Plus Postage. PC Not Available from EDRS. |
| DESCRIPTORS | Active Learning; Biology; College Faculty; College Freshmen; College Students; Computer Software; *Computer Uses in Education; Cooperative Learning; Critical Thinking; Distance Education; *Educational Technology; Foreign Countries; French; *Higher Education; Interactive Video; Internet; Learning Strategies; Online Systems; Peer Evaluation; Physics; Programming; Research Projects; Student Empowerment; Student Participation; Teacher Participation; Teaching Methods; Teamwork |
| IDENTIFIERS | Analytical Methods; Australia; Critical Events; Learning Communities; Scientific Thinking; United Kingdom; Visual Communication; Web Sites |

ABSTRACT

This collection of papers from an international conference on higher education teaching and learning includes: "Fostering Scientific Thinking with New Technologies: A Socio-Cognitive Approach" (Michel Aube); "The 'Classroom Flip': Using Web Course Management Tools to Become the Guide by the Side" (J. Wesley Baker); "Embracing Information and Learning Technology Within a New Learning Paradigm in UK Colleges" (C.J. Birch); "Project Based Learning: Equipment Specification" (Ed Boyapati); "Effective Teaching Using the Internet" (David Byres); "Empowerment Groups: A Creative Transition and Retention Strategy" (Joyce A. Carter); "Play it Again Sam: Creating Reusable Projects that Integrate Instructional Technology, Critical Thought and Active, Collaborative Learning into the Curriculum" (Karen Casto and Kris Bulcroft); "Critical Moments in College Teaching" (Michael Christie); "Paradigm Shift: Visual Communication and Empowerment" (Daniel J. Doyle); "Interactive Multimedia: Lessons from Learning Theory" (Richard Farr); "Asynchronous Discussions, Learning Communities and Participation of Students and Faculty" (Charles Graessle); "Edge of Chaos: The Sweet Spot for Internet-Rich Pedagogy" (Barclay M. Hudson); "Peer Critiques in the Teaching of Computer Programming" (William J. Joel); "Active Learning: Student Performance and Perceptions Compared with Lecture" (David A. Lake); "Improving Team Performance in Software Engineering" (Robert Lingard and Elizabeth Berry); "Innovative Strategies for Teaching and Learning at a Distance" (Pam Northrup); "Analytics: An Integrated Mathematics, Logic and Philosophy of Science Course" (Michael R. Pinter); "Andes: A Coached Learning Environment for Classical Newtonian Physics" (K.G. Schultz, R.N. Shelby, D.J. Treacy, and M.C. Wintersgill); "The Evolution of a Biology Course-Related Web

Reproductions supplied by EDRS are the best that can be made
from the original document.

Site" (Janet L. Stein Carter); and "French Topics Online: Natural Errors with Virtual Wine" (Katherine Watson). (Individual papers contain references.) (SM)

Reproductions supplied by EDRS are the best that can be made
from the original document.

ED 440 975

The Center
for the Advancement of
Teaching and Learning

# SELECTED PAPERS
# from the
# 11th INTERNATIONAL CONFERENCE
# on
# COLLEGE TEACHING
# AND LEARNING

Edited by
**Jack A. Chambers**

**Florida Community College**
**at Jacksonville**

BEST COPY AVAILABLE

SP039213

BEST COPY AVAILABLE

PERMISSION TO REPRODUCE AND
DISSEMINATE THIS MATERIAL IN MICROFICHE
AND IN ELECTRONIC MEDIA FOR ERIC
COLLECTION SUBSCRIBERS ONLY
HAS BEEN GRANTED BY

J. A. Chambers

TO THE EDUCATIONAL RESOURCES
INFORMATION CENTER (ERIC)

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

☐ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

**The Center**
**for the Advancement of**
**Teaching and Learning**

*SELECTED PAPERS*
*from the*
*11th INTERNATIONAL CONFERENCE*
*on*
*COLLEGE TEACHING*
*AND LEARNING*

**Edited by**
**Jack A. Chambers**

*Florida Community College*
*at Jacksonville*

Copyright, 2000, Florida Community College at Jacksonville. All rights reserved. No part of this publication may be reproduced in any form by any means without prior written permission from the publisher, with the following exceptions: 1) authors of papers published in this volume may reproduce copies of their own articles as indicated in the Publishing Agreement; and 2) reviewers may quote brief passages in review.

Center for the Advancement of Teaching and Learning, *Florida Community College at Jacksonville*, 601 W. State Street, Room 102, Jacksonville, FL 32202.

## CONTENTS

*Foreword* viii

***Fostering Scientific Thinking with New Technologies: A Socio-Cognitive Approach***
Michel Aube
*Universite de Sherbrooke, Canada* 1

***The "Classroom Flip": Using Web Course Management Tools to Become The Guide by the Side***
J. Wesley Baker
*Cedarville College* 9

***Embracing Information and Learning Technology within a New Learning Paradigm in UK Colleges***
C. J. Birch
*Staffordshire University, UK* 19

***Project Based Learning: Equipment Specification***
Ed Boyapati
*Royal Melbourne Institute of Technology Australia* 29

Selected Conference Papers

***Effective Teaching Using the Internet***
David Byres
*Florida Community College*
*at Jacksonville* 37

***Empowerment Groups: A Creative***
***Transition and Retention Strategy***
Joyce A. Carter
*Central Michigan University* 43

***Play it Again Sam: Creating Reusable***
***Projects that Integrate Instructional Technology,***
***Critical Thought and Active, Collaborative***
***Learning into the Curriculum***
Karen Casto
Kris Bulcroft
*Western Washington University.* 51

***Critical Moments in College Teaching***
Michael Christie
*Chalmers University of Technology*
*Sweden.* 61

***Paradigm Shift: Visual Communication***
***and Empowerment***
Daniel J. Doyle
*Pennsylvania College of Technology* 73

***Interactive Multimedia: Lessons from Learning Theory***
Richard Farr
*University of Nottingham, UK*
Martin Barber
*University of Salford, UK* 81

***Asynchronous Discussions, Learning Communities and Participation of Students and Faculty***
Charles Graessle
*Olivet College* 91

***Edge of Chaos: The Sweet Spot for Internet-Rich Pedagogy***
Barclay M. Hudson
*The Fielding Institute* 99

***Peer Critiques in the Teaching of Computer Programming***
William J. Joel
*Western Connecticut State University* 111

***Active Learning: Student Performance and Perceptions Compared with Lecture***
David A. Lake
*Armstrong Atlantic State University* 119

***Improving Team Performance in Software Engineering***
Robert Lingard
Elizabeth Berry
*California State University, Northridge* 125

***Innovative Strategies for Teaching and Learning at a Distance***
Pam Northrup
*University of West Florida* 133

***Analytics: An Integrated Mathematics, Logic and Philosophy of Science Course***
Michael R. Pinter
*Belmont University* 143

***Andes: A Coached Learning Environment for Classical Newtonian Physics***
K.G. Schultz
R. N. Shelby
D. J. Treacy
M. C. Wintersgill
*United States Naval Academy* 151

***The Evolution of A Biology Course-Related Web Site***
Janet L. Stein Carter
*University of Cincinnati* 163

*French Topics Online:*
***Natural Errors with Virtual Wine***
Katherine Watson
*Coastline Community College* 171

***Contributors*** 177

## FOREWORD

The Center for the Advancement of Teaching and Learning was developed in 1987 when Florida Community College at Jacksonville (FCCJ) accepted K. Patricia Cross' challenge to use the classroom as a modern laboratory for conducting experiments to gauge the impact of teaching on student learning.

The Center, with the philosophy that classroom teachers are the key to improving student learning, is composed of faculty members under the guidance of a steering committee which consists of faculty from each of five campuses of Florida Community College. Part of the Center's success can be attributed to the numerous opportunities given to faculty to test their teaching ideas and to put research results into practice.

The Center sponsors programs supporting faculty research mini-grants, case studies, portfolios, classroom research, cooperative learning, faculty workshops and adjunct faculty development. In recent years, the Center received the Theodore M. Hesburgh Certificate of Excellence for its faculty development programs.

In an effort to stimulate creative discussion and promote experimentation to improve the teaching/learning process, as well as to honor those who have already significantly improved learning in higher education, the Center annually sponsors an international conference. The conference features recognized educational leaders in diverse areas of teaching, learning and technology. Since its inception, the conference has grown yearly and now attracts a thousand scholars from around the world. This annual publication, *Selected Papers*, resulted from faculty interest in preserving and communicating some of the outstanding contributions to each conference.

Many people are responsible for the success of the conferences. Thanks to all participants--featured speakers and workshop leaders; presenters from universities, liberal arts and community colleges throughout the United States and abroad; and faithful attendees. A special thanks to the Steering Committee for The Center for the Advancement of Teaching and Learning and to Brenda Boccard, Ida Brown, Jeana Davis and Dennis Lewis.

Like the International Conference, this journal continues to grow and broaden its focus. This year's publication contains 20 articles from the *Eleventh International Conference on College Teaching and Learning* which represent a cross-section of the nearly 300 faculty presentations. More than 50 papers were submitted for consideration in this year's journal. Those that were selected for inclusion were juried by FCCJ faculty members. Papers were judged on the following criteria:

*Quality of content.

*Quality of writing and presentation

*Focus of the paper (i.e., teaching, learning, technology)

*Discipline

*Appeal to an audience of professional, post-secondary educators

*Theoretical or practical applications

We hope you will find the ideas presented herein applicable and inspirational to your own research and teaching. Please plan to join us at the *Twelfth International Conference on College Teaching and Learning*, April 18-21, 2001, in Jacksonville.

Jann MacInnes
Professor of Mathematics

Carolyn Phanstiel
Professor of English

John Mullins
Professor of Biology

Joann Carpenter
Professor of History

# FOSTERING SCIENTIFIC THINKING WITH NEW TECHNOLOGIES: A SOCIO-COGNITIVE APPROACH

**Michel Aubé**
*Université de Sherbrooke, Canada*

## INTRODUCTION

The integration of scientific disciplines into school curricula does not only aim to generate new researchers for the scientific community, it is a basic component of the general training that is required for adapting the new citizens to our technological society. One of the basic objectives of teaching sciences is to inculcate efficient tools for rigorous thinking and reasoning, thus fostering a proper comprehension of the complex issues with which our society is involved, along with a deep commitment to help resolving them.

Sadly enough, these goals are only partly met, since a significant part of the population comes of age without mastering critical and rigorous thinking. Yet, the constructivist bias that pervades cognitive science provides hope that the mental skills required are neither mysterious nor innate and that it is still worthwhile to try to specify which conditions could best sustain their acquisition.

## BASIC PRINCIPLES UNDERLYING THE APPROACH

At the core of this project, along the principles of the socio-cognitive approach, is the idea that scientific practice is

similar to language skills and practice and thus requires continuous exchange and dialogue with peers for mastery (Palincsar, 1998; Roschelle, 1993). Rules for rigorous thinking, as well as proper research attitudes, could thus be acquired more or less like rules of syntax or semantics, provided that students are involved, as adult researchers most frequently are, in significant communication and exchange with other researchers.

What is being applied here is the principle underlying what Vigotsky (1978) called the *zone of proximal development*. The concepts refers to the fact that child development cannot be satisfactorily assessed merely by observing actual performance. According to the Russian Psychologist, what must also be taken into account are the additional feats which youngsters can accomplish under the help and guidance of adults or elders. This refers to the fact that much of knowledge is progressively built by incorporating whole fragments of behavior borrowed from watching and imitating more successful beings and by interacting intensively with them. This suggests that young would-be scientists should be given the opportunity to interact seriously with expert scientists about the subject they are investigating.

Another crucial point is that students should be given the opportunity to participate in building and creating new knowledge to benefit their own community, a task for which they should be held responsible. Just as a Biochemist has the responsibility of testing carefully her/his new medicines before introducing them to the marketplace, each scientist is responsible for the new concepts and technologies s/he creates.

Moral concerns embedded in the above are not common concerns in the typical scientific curriculum of the schools, but should certainly be welcome. Yet the concern is more than ethics--being held publicly responsible for high quality products acts as a basic motivator throughout most of

human behavior and probably lies at the core of many scientific contributions. If this is indeed the case, why should young would-be scientists be deprived of such an attractor?

It is certainly obvious that to achieve powerful results requires appropriate tools, and multimedia technologies now permit the combination of many resources to facilitate high level creative activities. These include the uses of technology to access a multiplicity of information distributed over a variety of Web sites; accessing complex information of high quality content ; communicating quickly with a large community of experts for questions, exchange, discussion and validation; and producing and publishing rather easily for a broad audience.

## DESCRIPTION OF THE PROJECT

***Darwin's World***. *Darwin's World* (Aubé, de la Chevrotière & David, 1999) is an educational project aimed at developing scientific knowledge and abilities in young children, typically from 8 to 14 years of age. It is part of a larger project, *Cyberscol* (1999), which is aimed at providing primary and secondary school teachers with powerful tools, developed on the Internet, to help them meet the objectives stated within the governmental programs and curricula.

Many disciplines are covered in Cyberscol, from language skills to Physics and Chemistry. Although more specifically concerned with activities in Biology and the natural sciences, Darwin's World has actually been developed so as to foster and enhance rigorous thinking, along with the skills required to apply the scientific method. The various activities which are proposed within the project have been validated by a community of Biologists involved in various governmental or environmental associations, and some of them are further acting as consulting experts for the students, through electronic mail.

The project aims at exploiting systematically what multimedia technology could offer for articulate production and communication and for inserting students into real scientific communities as responsible peer researchers. It stems from a socio-cognitive approach and is based on empirical results from research in cognition, collaborative learning, the transfer of knowledge, science teaching and computer applications in education (Campione, Shapiro, & Brown, 1995; Palincsar, 1998; Roschelle, 1993).

***Learning Activity Example.*** One typical example of a learning activity developed in Darwin's World consists in the adoption, by a whole class of students, of an animal species from the local surroundings. The choice has to be approved by the project team (only one class per animal, so as to become the known specialist of the species), and it involves a commitment to produce, on the Darwin's World Web site, a complete card-file describing the identity and the ecology of the species.

The quality of content and presentation required, together with the spectrum of publication obtained on the Web makes such a task less like typical schoolwork and more like real scientific production. It is indeed more similar to the kind of content found inside some of the best guides used in university departments to train professional field Biologists.

In Darwin's World, the scientific content of the whole card-file has to be carefully validated by an expert Biologist through an ongoing exchange, and the texts also have to be validated as to their linguistic quality (composition as well as spelling). The students' commitment also includes continuing to update their information and presenting themselves as experts in cases of public (or even expert) questions coming through e-mail.

***Long-Term Projects.*** The approach also favors involvement in long-term projects rather than the typical short-term schoolwork. The author estimated that a class of about

25 students, 9 to 11 years of age, would easily spend a whole academic year to complete a card-file satisfactorily, through reading, searching, discussing, and even sampling observations from the field. However, the students and the teachers are not left alone in this complex endeavor.

The project Web site contains various examples, accompaniments and guides on-line, at the disposal of both the pupils and the teachers. Besides the research team itself, there is also at the disposal of the young researchers an increasingly growing network of other classes, teachers and experts from different countries, all contributing to the collective elaboration of this knowledge. Computer forms are also available on the Web site (using JAVA and SQL), to guide the students in searching for relevant data and selecting among them.

Students' results are saved within a growing animal data base. The Web site illustrating the card-file is automatically generated from these forms, and various multimedia elements (involving sounds, pictures, animations, links) can be inserted at will to enrich the ongoing description, provided they contribute to the descriptions or to the explanations required.

***Objectives.*** Many objectives are reached by the same token. The students are deeply involved in constructing their own knowledge about the chosen animal. There is also the high stake of publishing quality information able to be seen from all over the world--but which remains clearly associated with the students as authors and knowledge producers, whose names and photographs are posted on the site. It deeply motivates the students to do serious work and rigorous verification of all kind of information to be posted. Although requiring constant interaction with computers--thus fostering computer literacy--the project also incites students to look for (and double-check) various other sources of information, including books, journals, films, and people.

The complexity of the task also naturally leads to cooperation--individuals are not in competition as to filling the same card-file and the amount of work to be done makes them need each other. This creates a positive climate in the classroom. The quality of the site, with good photographs and illustrations, precise descriptions, and complete exposure of the behavioral ecology of the adopted species, also incites collaboration from the experts. They thus take it very seriously and have shown so far a generous involvement in the project, some even sharing unpublished data or photographs, with the consequence that their elaborate comments further motivates the students.

***Required Interaction with Experts***. Some parts of the card-file absolutely require interaction with expert Biologists. For instance, students have to raise at least one (and preferably more) interesting question about the species that have never been answered, and to propose a reasonable way of finding an answer to it. This clearly could not be completed without discussion with an expert who is already aware of the ongoing research and of the important questions concerning the species at interest.

Such a requirement tends to involve students and experts in serious dialogue. It raises in the students' minds the idea that expertise not only consists in knowing what is already known about a given subject matter, but also in identifying what important pieces of information are missing. It further leads to inquiry as to which problems are most crucial for current understanding and which are promising for future progress.

In the initial phase of the project, many teachers were skeptical about the capacity of young students to formulate really new questions that would prove interesting enough to raise the curiosity of experts and induce them to participate in serious and creative exchange with the students. It so happened that the students were often more daring than the

teachers themselves in formulating deep and appropriate questions about their species.

## CONCLUSIONS

A promising way of using communication technologies to enhance scientific thinking in young students has been proposed in this paper. The approach rests on offering students conditions similar to those that prevail among adults scientists themselves, who spend a significant portion of their research life interacting with peer scientists, but who also get recognition by expressing progress in building new knowledge through regular publications.

It is the author's belief that scientific rigor is largely dependent upon this process of reciprocal validation. In the future, this suggests a fresher look at the process of exchange itself, to check for instance whether the *zone of proximal development* could also operate the other way around--i.e., when dialogue gets as serious as has been observed between students and experts, could not the scientists themselves gain new insights as is often the case in discussions among adults researchers?

## REFERENCES

Aubé, M., de la Chevrotière, P., & David, R. (1999). Le monde de Darwin: Une application socio-cognitive des TIC pour la formation des jeunes à la rigueur et à l'esprit scientifiques. *Communication présentée au 67e Congrès annuel de l'ACFAS, Ottawa, CA.*

Campione, J. C., Shapiro, A. M., & Brown, A. L. (1995). Forms of transfer in a community of learners: Flexible learning and understanding. In A. McKeough, J. Lupart & A. Marini (Eds.), *Teaching for transfer: Fostering generalization in learning* (pp. 1-19). Mahwah, N. J.: Erlbaum.

Cyberscol. (1999).. [On-line]. Available: http://cyberscol.qc.ca.

Palincsar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology, 49*, 345-375.

Roschelle, J. (1993). Learning by collaborating: Convergent conceptual change. *The Journal of The Learning Science, 2*(3), 235-277.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge: Harvard University Press.

# THE "CLASSROOM FLIP":

# USING WEB COURSE MANAGEMENT TOOLS

# TO BECOME THE GUIDE BY THE SIDE

**J. Wesley Baker**
*Cedarville College*

## INTRODUCTION

The undergraduate college classroom is being changed by two converging trends. The first is a change in educational philosophy. Driven by the findings of cognitive science about how people learn (Caine & Caine, 1994; Reed, 1988), the new approaches to education view students as active discoverers of knowledge who learn best in a social setting in which faculty serve as mentors (Johnson, Johnson, & Smith, 1998). The shift from an *instructor* to a *learner* model has been summed up in the well-worn description: "From the sage on the stage to the guide by the side."

The second trend is the rapid introduction of new instructional technologies. Whereas the old technologies were passive, analog and linear, the new technologies are interactive, digital and non-linear. These characteristics provide a good fit with the new approaches to teaching and learning that have been developing during the same period. While many writers have supported the implementation of the technologies to support new theories of learning, little connection has been made with how college professors teaching courses on residential campuses can use these technologies to transform their classrooms. At least three factors have slowed the innovation. Two of them have started

to be addressed, but the third is still largely unexplored.

The first factor is that when these new technologies were introduced to faculty at the beginning of the 1990s the focus was on training--learning how to use the hardware and software with little, if any, emphasis on effective uses related to pedagogy. Since mid-decade, however, researchers and theorists have begun to make more explicit connections between pedagogy and uses of these new technologies (Jonassen, 1996; Najjar, 1996).

A second inhibiting factor is that faculty had to master complex authoring tools or cobble together several stand-alone pieces of software that did not interconnect. The process has been made easier with the introduction of Web course management software--programs such as Web Course in a Box, WebCT and Learning Space (Gray, 1998).

The third factor is that technologies such as online threaded discussion are often presented as tools to support a learner-oriented approach for distance education (Palloff & Pratt, 1999) without discussing how they might be used to accomplish the same goal by those who teach traditional college-aged students on residential campuses. This paper presents a model that seeks to bring the pedagogical and technological trends together in an approach designed to change teaching and learning in the traditional undergraduate classroom.

## GOALS

As Shambaugh & Magliaro point out, "...each theoretical approach to education has its own strengths and weaknesses" (Shambaugh & Magliaro, 1997, p. 29). The lecture, for example, is acknowledged by those advocating other approaches to be an efficient way of presenting information (Johnson, Johnson, & Smith, 1998). In addition, some of the gains in learning ascribed to multimedia may be

attributable to the design and increased interactivity of the instructional material (Najjar, 1996), suggesting similar gains could be achieved by applying those techniques to a classroom approach. Therefore, although the attempt to design this class model drew from cognitive approaches, it also sought to retain some of the strengths of the traditional lecture approach. The fundamental assumption was that the new information technologies would provide a way for faculty to present "lecture" material, but that the shift in method of delivery would open up classroom time for teaching and learning strategies that emphasized the role of the learner in a cooperative environment. Such a change would also allow the professor to move from purveyor of knowledge to mentor working in cooperation with student learners.

From the outset, a number of goals were set, including the following.

- Find an approach that would make it possible for faculty to move from *sage* to *guide*.

- Reduce the amount of time spent in class on lecturing, opening up class time for the use of active learning strategies.

- Focus more on understanding and application (critical and creative thinking) than on recall of facts (content/basic thinking), while not sacrificing presentation of the factual base (categories from Jonassen, 1996, p. 27ff.).

- Provide students with more control over their own learning,

- Give students a greater sense of their own responsibility for their learning.

- Provide students with more opportunities to learn from their peers.

## DESCRIPTION OF THE CLASSROOM FLIP

### Online Components for Out-of-Class Work

***Lectures.*** A key online component for the "flipped" class is the movement of lecture material out of the classroom through online delivery. Since the advent of Web course management software, the medium for this delivery of traditional class content has been Web pages, the use of which is monitored by the software.

***Threaded Discussion.*** A second online component is one usually associated with distance education--threaded discussion groups. In the traditional classroom, time constraints often truncate the discussion of student presentations. By moving that process online, classroom conversation is extended. Students are provided with the full written reports of their peers and have an opportunity for more interactive discussion than is possible in class.

Another advantage is that this asynchronous discussion gives a voice to many students who are silent during in-class discussions. Experience has shown that these students want time to prepare, edit and rewrite their comments before submitting them to peer review. With the discussion no longer time-based, these students are given the opportunity to go through those steps. Their contributions to the discussion are usually well thought-out and carefully articulated. Thus, the whole class benefits from the addition of their voices to the conversation.

***Quizzes.*** When asked to identify a frustration in their teaching, faculty will often list student motivation at the top of the list. They are concerned that students don't spend enough time with assigned readings to be adequately prepared for in-

class work. A third component--online quizzes--helps provide an incentive for students to keep up with assigned readings. The Web course management programs can make a quiz over readings available right up to the starting bell of a class, providing an incentive for students to read the material and be prepared for class discussion that day.

**Changes in the Classroom**

***Time for Active Learning.*** One of the immediate changes in the classroom is that the professor is freed from the "tyranny of the lecture"--the schedule imposed by the amount of material that has to be covered in class each session. With the essential class content available online, the professor is now free to use class time for other activities.

One approach to structuring the class revolves around four verbs.

- *Clarify--b*egin by discussing any questions the students have from the assigned readings for the session.

- *Expand--n*ext, invite the students to add to the assigned material by drawing from their own experience, other reading or what they have learned in other classes. This stage recognizes the students as co-contributors of knowledge and can help place the content for the day in a "real world" setting as students draw upon insights gained from their own life experience.

- *Apply*--one of the most important contributions of the model is the time it provides to concentrate on student understanding and application of concepts. Thus, on a "normal day" most of class time will probably be spent on this stage, where students are asked to apply what they have learned from the assigned materials. This model

provides a greater amount of time for these kinds of activities without sacrificing any of the course content.

- *Practice*--this stage takes application beyond the critique stage and involves the collaborative groups in creative thinking.

## STUDENT ASSESSMENT OF THE CLASSROOM FLIP

In order to determine whether or not the goals for the Flip were being met, students in two of the classes--Graphic Design for Interactive Multimedia and Communication in the Information Age--were surveyed for their perceptions of the implementation. At the end of each class, students were given a bank of attitudinal statements and asked to indicate the extent of their agreement or disagreement with the statements on a five-point Likert-type scale (on which 1=Strongly Agree). Initial results from the classes provided some evidence that the goals for the model were being achieved.

The most positive comments from students in the Graphic Design class came in response to these questions (from a bank of 22 questions):

> *The class encouraged me to spend more time collaborating with other students than I typically do in other classes. (1.3)*
>
> *Class discussions encouraged critical thinking. (1.4)*
>
> *Compared to other classes of this size, I felt that there was more personal attention provided me. (1.5)*

*I feel I learned from my fellow students through their presentations and comments in class discussion. (1.7)*

*The online resources provided me with more control over my own learning. (1.8)*

*In-class time was spent more in discussing implications than in presenting facts. (1.8)*

The most positive comments from students in the CIA class came in response to these questions (from a bank of 35 questions):

*In-class time was spent more in discussing implications than in presenting facts. (1.8)*

*Class discussions encouraged critical thinking. (1.8)*

*I was more responsible for my own learning in this class compared with others. (1.8)*

*The online material and in-class discussion made the course more of a forum than a lecture. (2.1)*

*I feel I learned from my fellow students through their presentations and comments in class discussion. (2.3)*

## CONCLUSIONS

Although the use of Web course management software is usually presented as a way to provide distance education, the features such software provides have utility for traditional face-to-face classes as well. Although a hybrid approach of using distance learning technologies to support classroom learning is just beginning to be explored, the Classroom Flip model suggests that college faculty can bring the benefits of increased interactivity and collaboration into their classes--both online and in the classroom--without sacrificing any content.

## REFERENCES

Caine, R. N. & Caine, G. (1994). *Making connections: Teaching and the human brain*. Menlo Park, CA: Addison-Wesley Publishing Company.

Gray, S. (1998). Web-based instructional tools. *Syllabus, 12*. [On-line]. Available: http://www.syllabus.com/sep98_magfea2.html.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). *Active learning: Cooperation in the college classroom*. Edina, MN: Interaction Book Company.

Jonassen, D. H. (1996). *Computers in the classroom: Mindtools for critical thinking*. Englewood Cliffs, NJ: Merrill/Prentice-Hall.

Najjar, L. (1996). Multimedia information and learning. *Journal of Educational Multimedia and Hypermedia, 5*, 129-150.

Palloff, R. M., & Pratt, K. (1999). *Building learning communities in cyberspace: Effective strategies for the online classroom*. San Francisco: Jossey-Bass.

Reed, S. K. (1988). *Cognition: Theory and application* (2nd ed.). Pacific Grove, CA: Brooks/Cole.

Shambaugh, R. N., & Magliaro, S. G. (1997). *Mastering the possibilities: A process approach to instructional design*. Boston: Allyn & Bacon.

# EMBRACING INFORMATION AND LEARNING TECHNOLOGY WITHIN A NEW LEARNING PARADIGM IN UK COLLEGES

**C. J. Birch**
*Staffordshire University, United Kingdom*

## INTRODUCTION

It is often said that the only certainty in the modern age is change, and this is certainly true in the world of education. This paper will investigate just how we are managing one dimension of this change, brought about by rapid, and radical technological developments.

> We live in a different world than the one in which (community) colleges were invented. Technology has transformed the ways in which we do business and live. Yet, it does not seem to have changed educational institutions to any great extent
>
> (Boggs, 1996, p.24)

Three years later, within UK Colleges, it could well be argued that this statement still holds true. Technology has continued it's inexorable march forward, but faculty still have not really learned to harness its power as an integral part of the learning process. An excellent report, commissioned by the UK Further Education Funding Council (1998), amplified this perspective. Within this report, the following statements were made:

*Since 1993, many colleges have made substantial investment in computer technology.*

*Few teachers routinely use IT in the classroom to improve the effectiveness of learning.*

*Where IT is used (to aid learning), it is often the result of individual enthusiasts.*

*The main use of computer equipment by students is in presenting assignments.*

*Little use is made of technology to assist students to learn independently.*

*The use of technology to support learning varies between colleges and between curriculum areas.*

*Only 10% of colleges in the survey monitor the use of hardware and software adequately.*

*Most colleges have policies relating to IT access, key IT skills development, conduct behavior, security, purchase and staff development (but not learning).*

*Teachers find difficulty in obtaining high quality, interactive learning materials.*

The implication is that while colleges have, on the whole, recognized the importance of the information technology revolution, they have only learned to use it in a

relatively superficial way. Students can often present their work well using modern software, they find information on the Web, and communicate with e-mail. College administration is usually based upon computerized systems. Arguably, in pedagogical terms, the impact of information and learning technology has been more limited, and that this is, in part, owing to the fact that those involved in the construction of learning processes do not have a real vision, or understanding, of the role that information and learning technology can play.

## THE SOCIAL AND ECONOMIC IMPERATIVE

The challenges facing constituents of the developed world are similar. The impact of high technology, the power of knowledge-based industries, the emergence of the global marketplace and the speed and variety of modern communications, have fundamentally changed the way that individuals and communities work.

> We are in a new age – the age of information and global communication. We have no choice but to prepare for this new age, in which the key to success will be continuous education and development of the human mind and imagination.
>
> (Her Majesty's Stationary Office, 1999, p. 1)

"Jobs for life" and set routines have long since gone, and government statisticians estimate that in the UK, average workers will change occupations seven times during their working lives. This will necessitate flexibility and the ability to manage continuous change in terms of knowledge, skills, concepts, ideas and attitudes. An essential attribute for survival will be the ability to learn quickly, and to adapt to the

rapid changes that will confront them. Everyone, if they want to keep up and stay involved, be it at home, work or play, will need to constantly re-skill, up-skill and be involved in a personal lifelong learning process. Those that cannot or will not, are likely to run the very real risk of social ostracism and disenfranchisement (Kennedy, 1997). It is important to recognize that technology will permeate all aspects of our lives.

The present UK government is committed to the vision of creating a Learning Society (Blunkett 1998). Widening participation, social inclusion, global competitiveness and lifelong learning have become everyday "buzz" phrases, but they underlie a genuine recognition that future prosperity is dependent on the creation of a high added value economy based on advanced skills, knowledge and training. To achieve this, individual lifestyles must be understood and learning opportunities must be varied, flexible, accessible and affordable. It is inconceivable that this can be effectively achieved without harnessing the power and opportunities provided by information and learning technology.

## INFORMATION AND LEARNING TECHNOLOGY AND THE LEARNING PARADIGM

Barr and Tagg, (1995) in their seminal work, emphasized the need for suppliers of learning opportunities to fundamentally re-think their mission, philosophy and *modus operandi,* focussing on learning and outcomes. Their advocacy of a 'new' learning paradigm is highly relevant in the context of the information age. The need and demand for learning opportunities have been accelerated by the ongoing hi-tech revolution, but at the same time, the ability of colleges to respond in appropriate ways have been limited by fiscal constraints.

Barr and Tagg (1995) suggest that students need to be encouraged to become independent learners, using a wide variety of inputs to help satisfy their needs. Information and learning technology provides the means to distribute a multiplicity of learning resources in a flexible and efficient way. The concept of learning on demand, at times and in places that suit the individual learner, is now a real possibility, facilitated by technological infrastructure.

The question is--can learning providers harness this potential? If they cannot respond to this challenge, it is questionable whether the wonderful aspiration of a genuine learning society can be achieved. There is little evidence from the developed world that traditional methods of post-compulsory education successfully attract sustained, mass participation in learning. What is needed is a radical new agenda, driven by the need to create effective and continuous learning opportunities, facilitated by capturing the power of information and learning technology. Visionaries are needed to lead this process--those that Charles Handy (1999) refers to as the *New Alchemists*.

## RESEARCH METHODOLOGY

Primary research was undertaken in October, 1999 to ascertain just what is happening in UK colleges, regarding their use of information and learning technology. Every college in England was sent a fax questionnaire. One hundred and two replies were received (24%), providing a representative sample. Essentially, three questions were asked: 1) Do you have a college wide (formal/documented) teaching and learning policy? 2) Do you have information and learning technology policies? and 3) Are you actively developing "electronic" (computer-based) learning materials? Follow up work with selected respondents has also taken place and a

range of secondary materials used. Summaries of the results are shown in Figures 1 and 2.

**Figure 1. Questionnaire Responses by Percentage**

Figure 1 shows that from the responses received, most colleges (66%) purported to be developing electronic learning materials, but significantly, a third were not developing anything. Almost half do not have formal college-wide teaching and learning or information and learning technology policies. Some were unsure as to whether they have formal policies, which is especially concerning given that the questionnaires were completed by "senior" curriculum officials. Few of those that were unsure made any mitigating comments

Follow up research indicated that in general, the quantity of materials being produced was minuscule in proportion to other learning materials, most of which continue to be paper-based. The quality of most materials produced was basic and often comprised no more than downloadable files on Web sites. Few materials were interactive or multimedia. This is not to infer that they do not fulfill a

purpose, but most could not be considered as "content innovative," or "learning stimulative."

Irrespective of the limitations, what they did demonstrate was a commitment by the organization to try to do something differently, and the beginning of a process to originate a gradual, evolutionary culture change. However, it is important to avoid technical determinism, which infers using technology because it is there and not because it is more effective in achieving primary goals (Retalis 1999).

**Figure 2. Developing E-Materials, But No Information and Learning Technology Policy or NO Teaching and Learning Policy**

Figure 2 is based on some simple cross tabulations. Of those colleges developing electronic materials, nearly 50% did not have formal teaching and learning policies, and well over 40% did not have formal information and learning technology policies. This perhaps infers that they are involved in a series of developments and activities without having a corporate sense of what they are trying to achieve. In short, product and resource development is happening without a strategic route map against which progress can be planned, monitored and revised if necessary.

Further investigation shows that what is happening in the development of new electronically-based resources is that individual, or small groups of product and/or process champions are experimenting in isolation, often in an ad-hoc way. Sometimes, such developments are not known to curriculum officials. There may be some virtues in this process. Individuals are using their talents and interests to try to do things differently. However, big questions are often unanswered from this approach, such as how is quality monitored and measured, how is good practice disseminated, are similar cohorts of students getting equal opportunities and how does it impact on overall college resource issues. *And perhaps most importantly, does it enhance the learning process, and if so, how?*

## CONCLUSIONS

It is clear that awareness is growing relating to the potential of information and learning technology. While most colleges have developed core information and communications infrastructure, they have not really come to terms with the pedagogical implications of how to begin to realize the potential of this investment. Technology enables, but it does not deliver learning independently of other major decisions.

Developments in information and learning technology need to be holistically linked to other policies relating to physical resources, finance, resource development teams, support facilities, course structures and timetables, staff recruitment and development, job/role descriptions and to quality processes. Successfully implementing information and learning technology strategies will largely depend upon the ability of those providing learning opportunities being able to recognize the pervasive, all-embracing, nature of information and learning technology. *A "piecemeal" approach is unlikely to yield the desired outcomes* (Barr & Tagg, 1996).

For any major development/change to be successful, ultimately it will need the commitment and support of all those involved, whether directly or indirectly. Inspired and empathetic leadership is essential to "sell" the opportunities afforded by information and learning technology, as well as to allay the fears or threats, in order that innovation and creativity can prevail.

The information and learning technology era has arrived, and for organizations that can capture the potential, the benefits may be great. Perhaps more importantly, modern society and the individuals concerned need learning providers to get this right--so that ultimately, the main winners are the future generations of learners and the communities in which they live and work.

## REFERENCES

Barr, R., & Tagg, J. (1995). From teaching to learning: A new paradigm for undergraduate education, *Change, 27*(6), 13-25

Blunkett, D. (1998) Positioning speech given to the Association of Colleges, Harrogate.

Boggs, G. (1996). The learning paradigm, *Community College Journal, 66*(3), 24-27.

Further Education Funding Council. (1998). *The use of technology to support learning in colleges*. Coventry, UK: Author.

Handy, C. (1999). *The new alchemists*. London: Hutchinson Press.

Her Majesty's Stationery Office. (1998). *The learning age*. London: Author.

Kennedy, H. (1997). *Learning works*. London: Department for Education and Employment.

Retalis, S., et. al. (1999). What educational challenges are we now able to meet, given that new technologies are available to students and the average citizen? In A. Eurelings, et. al. (Eds.), *Bringing information technology to education* (pp. 86-91). Maastricht, The Netherlands: Kluwer.

# PROJECT BASED LEARNING:

# EQUIPMENT SPECIFICATION

**Ed Boyapati**
*Royal Melbourne Institute of Technology, Australia*

## INTRODUCTION

The Royal Melbourne Institute of Technology *Teaching and Learning Strategy* states that it has a commitment to a 'student centered' approach to teaching and learning. In the *Policy on Accreditation of Professional Engineering Courses*, several attributes which graduates from accredited courses are expected to have are listed. These include the ability to communicate effectively; the ability to undertake problem identification, formulation and solution; the ability to function effectively in multi-disciplinary and multi-cultural teams; a capacity to undertake life-long learning, and adaptability--among others. These are also the skills employers expect of graduates. Employers and employer organizations are not satisfied that these attributes are being sufficiently developed in current engineering students.

There are several problems with the current traditional methods of training engineers–graduates appear to be too narrow in their vision, there are high failure rates etc. Anecdotal evidence suggests that engineering students are relatively weak in divergent thinking, communication and interpersonal skills--perhaps because those who possess these skills, in general, tend to "self-select" out of engineering for various reasons. It therefore poses academics a great challenge--and student learning predominantly by means of student-centered activities becomes of significant importance

in order to help students develop these skills which are critical to success on the job.

The traditional lecture-exam pedagogy encourages students to view problems and topics as isolated, idealized and exclusively technical. This in turn cultivates passive learning and individually-centered attitudes. A practicing engineer needs to integrate facts, deal with non-ideal systems, work effectively as part of a team and look beyond purely technical issues.

For many students, attendance at lectures is the only way they can find out what subject matter they will have to learn in order to succeed in the course. Surveys made by the author have shown that most students come to lectures not to learn, but to find out *what* to learn. In the usual lecture approach, less than 5% of the students are actively involved and 95% are not (Felder, 1992).

If students are to achieve critical thinking and other higher cognitive outcomes, it seems reasonable to assume that they should have an opportunity to practice applications, think critically and receive feedback on the results (Lally & Myhill, 1994). Student-centered activities such as undertaking real life, open-ended group based projects, provide an opportunity to do this (Wankat & Oreovicz, 1993).

Another advantage of project-based learning is that of developing skills in group membership and leadership. Studies have shown that students who are taught by such "participative-action" methods are significantly superior to students taught by traditional lecture method in role flexibility and self-insight (Wankat & Oreovicz, 1993).

## THE PROJECT

With the above in view, it was decided that a major project in a third year design course should form part of the

assessment. A small part of the project description as given to students is reproduced below:

> *Imagine that you are working as a Project Process Engineer and you need to buy a piece of process equipment from an equipment vendor/manufacturer/fabricator (the choice of equipment is up to you). You can make up your own process specifications scenario (hypothetical or real).*
>
> *You may need to write to the supplier asking for information. You will find that, in general, the companies you will need to liaise with will be happy to help you (you may be their potential future customer!). Based on the advice given by the company representative and research, and your requirements, you are to select/specify size/design an appropriate equipment for the purpose.*

Clear guidelines on the format of the report are given to the students. The students are advised that the project will take a very long time to complete because of the difficulty in obtaining the information, making contacts with relevant companies etc. Some project management principles are outlined as a guide. Since many students are unaware of the sources of information, some generic information sources are given to them (such as databooks, relevant periodicals, abstracts, codes and standards, trade exhibitions etc). About 25 examples of Equipment/Accessories they could choose are also given.

Based on the research carried out for the project, students were expected to make seminar presentations, as well as a report submission. Any one of the group members, chosen

at random, was asked to make the presentation so that all students were prepared for the presentation.

The purpose of the seminars was to disseminate to their colleagues what they had learned about researching the design methods, selection and sizing of equipment and accessories, obtain feedback and develop their communication skills and ability to work in groups. To ensure that the students attended the seminars and took initiative in making a good quality presentation, they were reminded that an examination question might be drawn from these presentations. Students were also given guidelines regarding the oral presentations.

Some of the comments made by students who undertook the project--as listed in their "reflections" section of their report and comments made on their subject evaluation using open ended questions (Eley & Thomson, 1993)--are reproduced below:

> *One important thing that struck us was the importance of planning throughout the assignment.*
>
> *We realized the importance of keeping up-to-date with process equipment by attending trade exhibitions and reading relevant literature.*
>
> *This assignment gave a very good overview of and practice in the process of selecting equipment, which is a very important part of an engineer's job.*
>
> *It provided an excellent opportunity to make contact with people in industry, which will be useful for our career.*

*It helped us to develop communication and interpersonal skills.*

*Setting out hypothetical, yet realistic process conditions is a lot harder than we expected.*

*We learned a lot of things from this project, such as our research skills, communication skills and team work principles.*

*This was a very challenging project, one that gave us an insight into what working life of process engineers is like--constantly faced with open-ended problems that can only be solved through creative thinking, cooperation and discipline.*

*It is only after doing this project that I realized that real life problems have an infinite number of solutions!*

*The project is interesting because it is real.*

*Projects such as these develop problem solving and other generic skills, which is much better than 'information transmission'.*

*The project made us aware of the importance of developing the skills considered desirable by employers.*

Advantages of the novel project based approach include the following.

- Students can develop an area within the subject matter that is of particular interest to them since *they* choose the topic. Since they have freedom in the choice of the topics for Project work, they display enthusiasm and interest in their work as reported by McKeachie (1986).

- Students develop their team work skills, communication skills and ability to empathize and appreciate others' point of view.

- Follow-up surveys have shown that doing this project has been of particular use to students for their later year "Design Project," for job interviews and in their professional careers. Employers in their quest for greater worker empowerment are increasingly using a self-contained work team approach.

- Students in general are unaware of the resources available to solve open-ended real life problems. However, by the time they have completed the subject, they become well aware of the range of resources (such as the ACEL Engineering Index, the Standards, process engineering journals, engineering index etc) available and the means to obtain and effectively use them for equipment selection, specification, sizing and design. They also become independent in learning about design of process equipment and accessories.

- Students get to know the methods of establishing contact with suppliers, and develop their ability in liaising with equipment vendors in equipment selection. The approach develops their initiative, independence and responsibility in preparation for the real world of work.

## CONCLUSIONS

The project-based approach outlined in this paper has resulted in helping students in a number of different ways. It has helped them to think, to evaluate information in making informed decisions, to interact positively with other students and to develop team work--all attributes considered desirable by employers.

## REFERENCES

Eley, M. & Thomson, M. (1993). *A system for student evaluation of teaching.* Canberra, Australia: Australian Government Publishing Service.

Felder, R. M. (1992, Winter). How about a quick one? *Chemical Engineering Education*, 19.

Lally, M., & Myhill, M. (1994). *Teaching quality*. Canberra, Australia: Australian Government Publishing Service.

McKeachie, W. J. (1986). *Teaching tips*, (8th ed., p. 144). Lexington: DC Heath.

Wankat, P. C., & Oreovicz, F. S. (1993). *Teaching engineering*. New York: McGraw Hill.

# EFFECTIVE TEACHING USING THE INTERNET

**David Byres**
*Florida Community College at Jacksonville*

## INTRODUCTION

The Internet is a valuable educational tool, offering many opportunities for meaningful learning (Bass, 1999). Use of computers has been shown to increase the understanding of material and achievement of students compared to traditional lecture ( Hacker & Sova 1998). In science classes, students who used the Web learned much more in-depth knowledge than those in an all-lecture course (Gilmer, 1999). Many Internet sites offer multimedia experiences--with combinations of sound, text, photographs and video--and studies have shown that learning is improved when information is processed through two channels (Mayer & Moreno, 1998). However, one major problem is that Internet resources are growing so fast and changing so quickly that even listing them in a written publication is impossible ( Ng & Wong 1999).

A major problem that can hinder effective use of the Internet is that new resources appear, old ones disappear and locations change. Students therefore need guided explorations to help them use resources rather than letting them browse on their own ( Ng & Wong 1999). Without a well structured environment, many students can fail to understand basic concepts, particularly in the sciences (Pearsall, et. al. 1997 ). One solution to these problems is to use a combination of a workbook listing specific Websites and questions relating to these sites picked by the instructor (see Byres, 2000a) and an online Web table (Byres, 2000b) to update Web sites that have changed .

## WORKBOOK

Internet Websites vary widely in content. Much of the information available is either too simple for college level work or too difficult for students to understand. Once students find a Website that is at the appropriate level, they often have difficulty picking out relevant or important information from a Website that may include hundreds of pages.

One way to guide students is for the instructor to pick out Websites that cover certain topics and then provide questions for students to answer dealing with specific areas of these sites. In this way the students' search can be directed, so that they do not become frustrated with the huge volume of information available on the World Wide Web.

In this paper one example of a workbook "Internet Biology" (Byres, 2000) will be used, although the idea can easily be adapted to any subject matter. It is also quite feasible for instructors to store their own workbook on the computer and print out chapters for students when they are needed.

The workbook divides the subject into chapters that generally correspond to chapters in the main textbook. For example there could be chapters on *The Scientific Method* or *Population Genetics*. Typically each chapter is designed to engage the student for one to two hours. The student logs on the Internet and is directed to between four and eight Websites. The workbook then has questions relating to each site.

Questions can be of any type--multiple choice, short answer, fill in the blank, essay, or any combination of these. To retain some flexibility some questions may be open ended (give your own opinion about....), or the answers can vary over time. For example, students may be directed to a Website that regularly updates its information (such as The New York Times or The New England Journal of Medicine ) and asked to summarize an article that was published the previous week.

The workbook can either be used individually by students, or it can be adapted for cooperative learning. For example in the "jigsaw" technique, students are divided into groups of three or four and each student studies a different group of Websites and brings the results back to the group.

Apart from providing the instructor with the ability to chose the appropriate material, one advantage of directing students to particular Websites is that these can be chosen so that they incorporate text, graphics, photographs, sounds (such as frog calls ) and video. At the end of a chapter, when students have a good understanding of the material, they can be asked to explore on their own using a search engine and to develop a list of other Websites that contain relevant information.

## WEB TABLE

Most college textbook now include a list of "Useful Websites," but a major problem with these is that the Internet changes so fast that many Websites have moved location or are no longer available by the time the book is published. The same problem occurs with a commercially published workbook, like the one described above.

To surmount the above difficulty, a table can be set up on the instructor's Home Page on the World Wide Web where students can click to access the Websites from each chapter. In this way, if a Website address changes, the new URL (such as http://cnn.com ) can be put in this table. When a student clicks on the Web table, they are taken directly to the new location, and do not even notice that the Web address has changed. For an example of a Web table see Byres (2000b).

If a Website later becomes completely unavailable, either alternative sites can be listed in the Web table, or the instructor can write his/her own information as a Hypertext Mark-up Language (HTML) document and access it through

the Web table (HTML is the language used in writing Web pages). The Web table can easily be adapted for any subject matter. In this way, the Web site addresses can be kept up to date, so that students are not frustrated by messages such as "URL not found".

## CONCLUSIONS

The use of a simple workbook, with Websites and questions chosen by the instructor, allows the Internet to be used effectively by students. It guides their explorations, ensures that students find the subject presented at an appropriate level and develops their skill at picking out relevant information. The workbook can be adapted for any subject matter. To avoid the problem of the fluidity of Internet Websites, a Web table on the instructor's Home Page can permit new Web addresses (URLs) to be substituted for the old ones, so that current information is maintained. Finally students can add to this body of information by locating new Websites that are pertinent to the subject.

## REFERENCES

Bass, R. (1999). *A framework for new media environments and the teaching of literature, culture and history*. [on-line]. Available:
http://www.georgetown.edu/crossroads/ctl/framework.html

Byres, D. (2000a). *Internet Biology*. St. Paul, MN: Paradigm Custom Publishing.

Byres, D. (2000b). Web Table. [On-line]. Available: http://web.fccj.org/~dbyres/internet.html.

Gilmer, P. (1999). Teaching biochemistry using the World Wide Web. In J. A. Chambers (Ed.), *Selected papers from the Tenth International Conference on College Teaching and Learning* (pp. 49-58). Jacksonville, FL: Florida Community College at Jacksonville.

Hacker, R., & Sova, B. (1998). Initial teacher education : A study of the efficacy of computer mediated courseware delivery in a partnership context. *British Journal of Educational Technology, 29(4),* 333-341.

Mayer, R. E., & Moreno, R. (1998). A split attention effect in multimedia learning. *Journal of Educational Psychology, 90,* 312-320.

Ng, V. M., & Wong, K. Y. (1999). Using simulation on the Internet to teach statistics. *Mathematics Teacher, 92,* 729-733.

Pearsall N. R., Skippin J. E., & Mintzes J. (1997). Knowledge restructuring in the life sciences: A longitudinal study of conceptual change in biology. *Science education, 81,* 193-215.

# EMPOWERMENT GROUPS:

# A CREATIVE TRANSITION

# AND RETENTION STRATEGY

**Joyce A. Carter**
*Central Michigan University*

## INTRODUCTION

Many current and incoming students are at risk in the university setting. They have transitional needs not generally met by traditional support services. Perfectly competent and capable students fail. Traditional thinking is that these students simply lack a skill. Perhaps they need to learn better reading techniques, manage their time and resources more effectively, or approach the studying for and taking of tests differently. These students are remediated into reading courses, study skill courses, writing courses and/or are linked with a learning center.

Some students seem to be without apparent goals. These students are often sent on career exploration searches on the supposition that a clear goal will reinforce motivation. Certainly for many students these prescriptions do assist them toward academic success. But there persists a sizable group of students whose transition evades traditional remedies.

Many students who fail to connect, academically achieve and thrive at the university bring with them significant high school grade point averages and solid ACT and/or SAT test scores. However, at the end of the academic year, they are asked to leave the university because their grade points are below minimum requirements. Often these students do not

understand either how to tap their own abilities or how to connect with the resources provided by the university community. The student who fails to thrive is in worse condition than the individual who never comes to the university because that student now lives with a sense of failure. The university is also in a worse situation as it now has an unhappy ex-student back in the home community.

This paper outlines the philosophy, strategy, and assessment outcomes of a group mentoring program which sharply reduces the incidence of these kinds of events. The program empowers and connects students, with the desired results that they remain and graduate.

**History Of Early Applications**

The earliest application of the group mentoring process at Central Michigan University began in the 1996 spring semester with an experiment now called the Academic Enhancement Program. This project began with a desire to assist that relatively small group of students who had academic potential but had experienced academic failure. Early success helped establish this program as an intrinsic part of the University's remediation for students returning from academic dismissal. This program is now in its eighth semester of application. Continued program evaluation and assessment indicates that outcomes for this program remain high. The Freshmen Empowerment Program began in the 1998 fall semester, and grew out of this earlier program.

## DESCRIPTION OF THE STUDY

Once the group process had been developed it was applied to in-coming freshmen. This group of students was selected because the largest loss in retention usually occurs during the freshmen year and between the freshmen and

sophomore year. Also, "Freshman success is enhanced by a campus climate that promotes student-to-student interaction" (Upcraft, et. al., 1990, p.9). Therefore, the cornerstone of this process was a small group intervention in which students could engage in dialogue with each other, a student facilitator and an adult facilitator.

The traditional classroom setting allows for the exchange of a great deal of both knowledge and information, other skills can be learned through tutoring, and yet other skills through computer-based learning. All of these methods give receptive students a chance to add to their store of information and skills. Most systems of higher education use all of these in addition to more specific settings.

The group process provides a different form of receptivity. This method allows students both the space and the time to begin to find their own voices. The group is an excellent experiential setting for students as they work on the developmental issues of their age--balancing their need to advance beyond dependence on family and tradition so that they may experience themselves more fully, and their need to be included in both the home culture from which they came and the campus culture in which they reside.

It seems that by just being with other students in the group setting, they are helped to honor their struggles while increasing their ability to take charge of their academic lives. They become *active students*. They begin to engage in the process. Frequently they struggle to begin the process and are not strong participants, but by the end they often have trouble coming to closure. It is startling to see students go from leaning back and away from the group on their first day, to leaning forward and leading discussion by the end of the process. Students seem to develop best under their own power, but they do appear to need some facilitation and a community from which to work. "Education is something we neither 'give' nor 'do' to our students. Rather it is a way we

stand in relation to them" (Daloz, 1986, p. xv). Certainly our first step is to engender trust; not only trust with faculty, counselors and other students, but trust within themselves, and trust in a transformational process. The goal is to provide a process whereby the student can develop a voice. A process wherein "each student [man] wins back his right to say his own word, to name the world" (Freire, 1984, p. 13). A process of empowerment. The intent is that with this empowerment the student can become connected to the university, look toward a future of academic success, and remain connected to family and home.

The goal of this initiative was two-fold. As an outcome of their interaction within the group process, students would experience a sense of power over their own lives. They would visualize their abilities and goals more clearly and be able to use their abilities to move toward their goals. They would become self-directed, taking responsibility for such activities as selecting an academic path, using student services and meeting with professors. In short, they would come to recognize that they hold their academic future, as well as their lives, in their own hands, and that their decisions, their choices and their ability to follow through are essential to their success.

This group process also assists students in connecting to the university community. They form a bond with other students and assist each other with problem-solving, engage in group activities, exchange information about extra curricular activities and develop a support team. They form study groups. They eat dinner together. They network about professors and majors. They attend alternative spring break activities. They engage in activities required to form a community, a community that works for them.

The group process provides an additional link. Students engage with a university professional and a graduate assistant on a weekly basis. This gives them both a solid

connection to the university and a venue for sharing with and being heard by an adult who has succeeded in the academic setting. For some students this is the only adult relationship they have on a regular basis which allows them to voice their concerns, their fears, their aspirations and their dreams. This is a relationship in which they are heard; where the listener assists them in taking an active role as they weave through that first confusing tangle of "college" and more adult, independent living.

Within the groups, students share, listen, argue, confront (themselves and others), support, and in many ways make meaning of their experience of becoming a student. They volunteer into the group process as freshmen because it assists them in getting to know other students and offers them community. Students who come to the group process as academically dismissed students participate because the process offers them a final opportunity to be successful as college students.

The Freshmen Empowerment Program is an integral part of the Academic Assistance Programs office and an outgrowth of the success of the Academic Enhancement Program. With the award of a three year FIPSE grant (Fund for the Improvement of Postsecondary Education) and matching university funds and expertise, the university was able to hire a full time educator to coordinate the program, and three graduate assistants to co-facilitate the groups. Each group is co-facilitated by either the author, the coordinator, or one of the graduate assistants and a student facilitator. The student facilitators are selected/volunteers from past Academic Enhancement Groups . This is a treasured role for these students; they feel they are giving back something of value to the university, and this exchange of gifts assists in their commitment to the university.

The graduate assistant positions are highly valued. Students enrolled in Counseling and Psychology programs

form the selection pool. These positions not only assist the recipients financially (they receive a stipend and 20 hours of tuition), but they also gain valuable work experience. As the program grows the staff seeks additional ways to support more groups without increasing the need for additional funding.

## FINDINGS

Fifty-three students participated in the Freshmen Empowerment Program during fall 1998 (n=53). Another fifty-three incoming freshmen were selected for the control group. Individuals were matched for gender, ethnicity, ACT and entering high school grade point average. By the completion of the fall semester, three students in the Empowerment Program had withdrawn from the University and nine students from the control group had withdrawn.

At the end of fall 1998 the average grade point for the Empowerment Program participants was 2.26 and for the control group was 1.51. Even greater gains were seen at the end of spring 1999 semester. The Empowerment participants had a grade point average of 2.70 with seven of the participants being academically dismissed. The control group had a grade point average of 1.70 with twenty of them being academically dismissed.

Freshmen Empowerment Program participants returned to Central Michigan University for their sophomore year at the rate of 81%. Students in the control group returned to their sophomore year at the rate of 45%. The overall retention rate at Central Michigan University during the same time period was 77%.

While these gains seem exceptional, they were not surprising. Earlier experimentation by the staff with this group process with students who had been academically dismissed and allowed (after some time) to reinstate, had been similar

During the 1996-1997 academic year, 82.6% of the dismissed/readmitted students who participated in a pilot study using the group process were retained and readmitted the following semester, while only 26.3% of the dismissed/readmitted students who did not participate were retained. The university is currently in the fourth year of the group process for academically dismissed students (entitled the Academic Enhancement Program) and the success rate continues to be high.

## CONCLUSIONS

Currently, despite its name, the Freshmen Empowerment Program is launching a major initiative to include first semester transfer students. This particular group currently has a 12% failure rate and it is felt that the group process can make a serious impact on academic success.

The group mentoring process is highly adaptable. The focus can change to fit the needs of the populations being served. Additional applications may include adult learners or non-traditional students, students on academic probation, high school bridge programs, residential college participants, and student athletes. Applications are limited only by the the individual's own thinking and the availability of resources.

At this point the university's role is two-fold. The primary goal is to continue the high success of the group process and continue to build a strong retention rate among the various groups of students, while continuing to secure a stable funding source so that the good work can be continued.

## REFERENCES

Daloz, L. (1986). *Effective teaching and mentoring: Realizing the transformational power of adult learning experiences.* San Francisco: Jossey-Bass.

Freire, P. (1984). *Pedagogy of the oppressed.* New York: Continuum.

Upcraft, M., et. al. (1990). *The freshman year experience.* San Francisco: Jossey-Bass.

# PLAY IT AGAIN SAM:

# CREATING REUSABLE PROJECTS THAT INTEGRATE INSTRUCTIONAL TECHNOLOGY, CRITICAL THOUGHT AND ACTIVE, COLLABORATIVE LEARNING INTO THE CURRICULUM

**Karen Casto**
**Kris Bulcroft**
*Western Washington University*

## INTRODUCTION

Educators are charged with designing dynamic curricula, but this can be difficult in an instructional environment that is constantly changing. Many of these changes are driven by an increasing emphasis on creating ways to objectively measure student learning. The real challenge is to find a way to manage the persistent change so that it is "implemented and routinized throughout the organization" (Salisbury, 1996, p. 149). Institutions can "routinize" change by creating well-designed, reusable instructional resources that are systematically integrated into the curriculum and which focus on achievable student learning outcomes. These resources could also provide models for educators in other institutions.

The idea that learning can be more effective if active, collaborative learning strategies are incorporated into the

curriculum has been supported by educational research (Brandon & Hollingshead, 1999; Ebert-May, Brewer, & Allred, 1997; Emerson & Mosteller, 1998; Pychyl, Clarke, & Abarbanel, 1999). Problem-based or project-based teaching methods also enhance the learning process, as made evident in recent cognitive research on human learning (Barron et al., 1998; Ram, 1999).

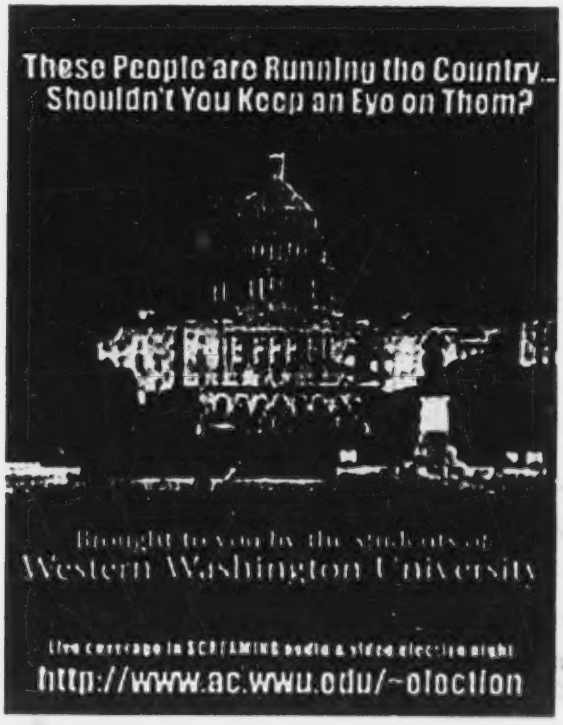
New instructional technologies can help meet the challenges created when institutions try to embed pedagogies for critical thinking and active, collaborative learning into their curricula. For example, the Internet can be used as a source of information for collaboration. Electronic "discussion boards" can be used to aid students to actively work together on team projects. Video conferencing can link campuses together to work on a common project, and presentation programs can allow students to actively participate in the learning process. Using instructional technologies to enhance the teaching and learning process bridges the gap between learning theories and instructional practice.

The challenge for institutions has not been visualizing how these technologies can be used, but how to provide consistent, economical, and effective support for those who wish to use them. Institutions are now realizing that support for instructional technology cannot just focus on early adopters and heavy users of information technology, but needs to be broader-based (Donovan, 1999). Providing this support for sound pedagogical reasons allows for consistent change.

## WWU'S ELECTION PROJECT

Western Washington University's Election Project was created for an introductory political science course reserved especially for entering freshmen at the university. Scheduling the project during the Fall 1998 elections made the project more "real and interesting" to the students (see Figure 1).

**Figure 1. A Publicity Campaign Helped Increase Student Motivation For The Project.**


These People are Running the Country..
Shouldn't You Keep an Eye on Them?
Western Washington University
http://www.ac.wwu.edu/~election

At the beginning of the course students were randomly assigned to teams based on four concepts as they related to U.S. elections: gender, ideology, political parties, and money. Each of the four teams took information generated by written team reports and created its own Website that was archived on the University's Web server (Western Washington University, 1999). Five-minute video updates based on the team reports were also streamed live on the Internet on Election Day.

The Election Project enabled students to locate and critically evaluate discipline-specific sources of information, to fully understand important concepts in an academic discipline and to communicate their own analysis of information and



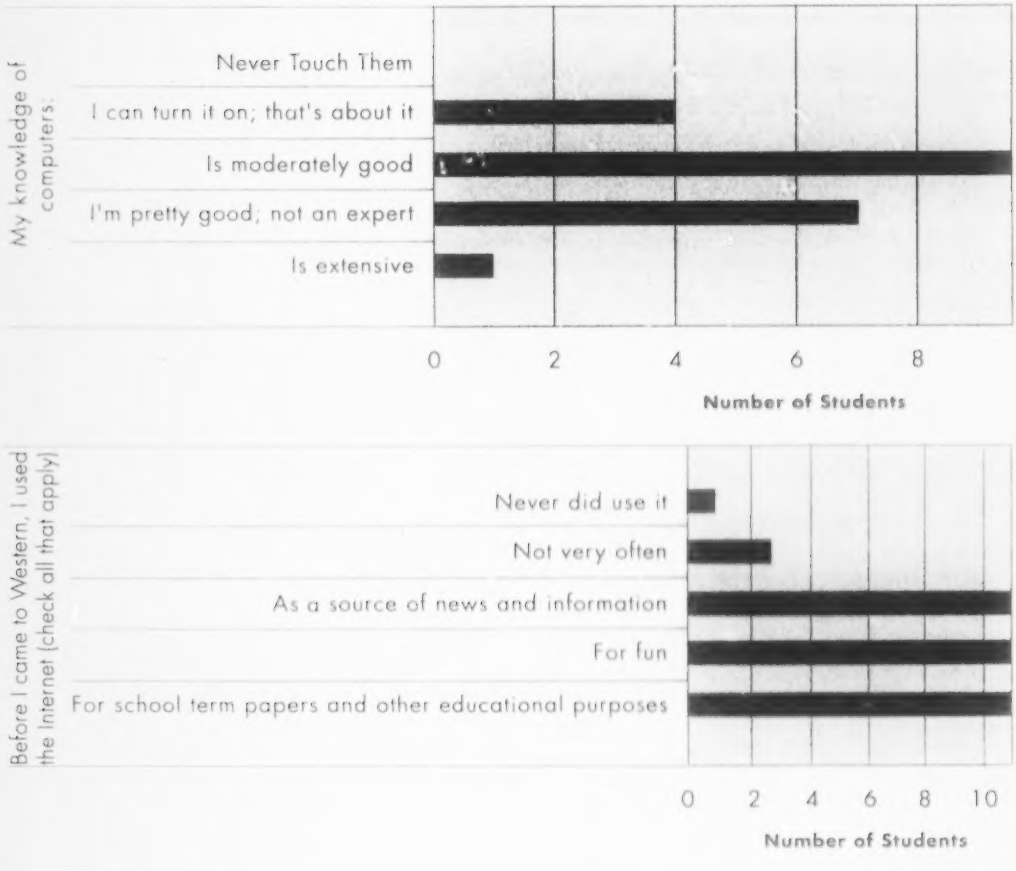
BEST COPY AVAILABLE

evidence concerning these concepts. Because the project was team-based, students also actively participated in their own learning and collaborated with others.

With the guidance of the course instructor and his graduate assistant, students engaged in initial research of their team's area and generated hypotheses based on this research. The university's government documents librarian and the social science librarian assisted the student teams in seeking and critically evaluating Internet sources of information for their reports.

The students further researched the hypotheses and developed team reports that served as the basis for the student-created Websites. The Center for Instructional Innovation provided technical support, although the students did an excellent job of working out the technical problems themselves. None of the students had ever created a Website before, nor had they ever streamed video on the Internet prior to this experience. Most students had used e-mail and used computers for term papers or other educational purposes, but only one student indicated that his/her knowledge of computers was extensive (see Figure 2).

**Figure 2. Survey Of Skills And Attitudes About Computers And The Internet From Students In The Election Project (Survey Administered The First Week Of Class).**




Throughout the process, the students were interested, engaged, and excited about the material they were learning. On Election Day, the students were lined up in front of the

BEST COPY AVAILABLE

office where the videos were to be produced hours before the reports were scheduled for streaming on the Internet. The students stayed well into the evening, watching the election returns on the Internet and on television and watching each other's live reports. The quality of their work, especially considering most of them had only recently graduated from high school, was amazing. Each team accomplished far more in terms of quantity, quality, and experiential learning than any one student could have working alone.

This project was carefully designed to promote active, collaborative, project-based learning strategies that enhanced the students' learning. It also exposed students who were new to the university to the library and technical support infrastructure. This exposure is not often part of the formal orientation process and may be very useful, if not essential, to them in their later careers.

## SUSTAINING CHANGE

The Election Project used substantial institutional resources, including half of the time of the Program Developer at the Center for Instructional Innovation for a period of several weeks. It also involved substantial restructuring of an existing course, quite an investment on the part of the instructor. The library also contributed time and resources and the Political Science Department allocated a graduate assistant to the course.

If the project were to be used only one time for this one course, it would not have been economical to commit so many resources to such a venture. However, this project can easily be re-used during the next election cycle in the fall of 2000 without the investment of time and resources required on the first go-round. It is also apparent that such a project could be easily adapted and used for a journalism, communications, English composition, or even an American history course.

Furthermore, universities throughout the United States could use such a project, as long as the project were carefully described and supporting materials were available.

As part of a desire to create a bank of well-designed projects that could be used in courses, the Center for Instructional Innovation at Western Washington University (1999) created a Website that will in the future describe in detail such projects. The Election Project is but one of many that will be shared with other members of the university, with other institutions in the state, and eventually as part of a nationwide project bank. This will be created along the lines of "Share Carolina" (University of North Carolina, 1999), an initiative sponsored by the University of North Carolina at Chapel Hill to share its instructional Internet development tools.

The showcase Website at Western Washington University describes the project in detail, and includes a project portfolio of lesson plans that can be followed by instructors. It also showcases the student work that was created as a result of the pilot project. Another portion of the Website demonstrates how each part of the project meets institutional and statewide goals for incorporating writing, critical thinking, instructional technologies, and information-seeking skills into the curriculum.

## CONCLUSIONS

Western Washington University's Election Project is an example of a portable, repeatable project that is research-based, answers institutional challenges, and meets the state legislature's accountability goals. The pedagogy drives the technology and is worth the time and effort, because it is "portable;" that is, it can be used again and again. It is one way to sustain the many changes that are occurring in higher education. Sustainability does not lie in the technologies

themselves, however, but in our ability to use them efficiently to achieve demonstrable student learning outcomes.

## REFERENCES

Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., & Bransford, J. D. (1998). Doing with understanding: Lessons from research on problem- and project-based learning. *Journal of the Learning Sciences, 7,* 271-311.

Brandon, D. P., & Hollingshead, A. B. (1999). Collaborative learning and computer-supported groups. *Communication Education, 48,* 109-126.

Center for Instructional Innovation at Western Washington University. (1999). *Reusable projects.* [On-line]. Available: http://pandora.cii.wwu.edu/showcase.

Donovan, M. (1999). Rethinking faculty support. *The Technology Source.* [On-line]. Available: http://horizon.unc.edu/TS/development/1999-09.asp

Ebert-May, D., Brewer, C., & Allred, S. (1997). Innovation in large lectures--teaching for active learning. *Bioscience, 47,* 601-607.

Emerson, J. D., & Mosteller, F. (1998). Interactive multimedia in college teaching. Part II. Lessons from research in the sciences. In R. M. Branch & M. A. Fitzgerald (Eds.), *Educational media and technology yearbook.* (Vol. 23, pp. 59-75). Englewood, CO: Libraries Unlimited.

Pychyl, T. A., Clarke, D., & Abarbanel, T. (1999). Computer-mediated group projects: Facilitating collaborative learning with the World Wide Web. *Teaching of Psychology, 26,* 138-141.

Ram, P. (1999). Problem-based learning in undergraduate education. *Journal of Chemical Education, 76,* 1122-1126.

Salisbury, D. F. (1996). *Five technologies for educational change.* Englewood Cliffs, NJ: Educational Technology Publications.

University of North Carolina. (1999). *Share Carolina.* [On-line]. Available: http://www.unc.edu/courses/ssp/share/.

Western Washington University. (1999). *The election project.* [On-line]. Available: http://www.ac.wwu.edu/~election.

# CRITICAL MOMENTS IN COLLEGE TEACHING

**Michael Christie**
*Chalmers University of Technology, Sweden*

## INTRODUCTION

This paper draws upon the writing of a number of scholars including the translated work of Pierre Bourdieu (1977; 1990; 1991; Bourdieu & Passeron, 1979; Bourdieu, Passeron & De Saint Martin, 1994) and books by Jack Mezirow (1990; 1991) and Stephen Brookfield (1990; 1991; 1995). In terms of research paradigms the study is best described as a piece of qualitative research. Bourdieu's seminal work *Outline of a Theory of Practice* (1977) and his subsequent writing on education have influenced the nature and direction of the study and some of the terms that are used in it. Mezirow's (1991) theory of transformative learning and Brookfield's (1991) work on hunting assumptions have been used both in the research design and the collection of data.

Although this paper refers to "critical moments" it owes much to the critical incidents technique, a research method developed by the American psychologist, John Flannagan (1954). Flannagan collected large numbers of specific incidents from people involved in a particular field and analyzed them in order to establish the critical requirements for success or failure in that field. Since Flannagan's early work, others (Corsini & Howard, 1964; Domas, 1950; Jensen 1951; Killen, McKee, Macleod & Spindler, 1983; Largravier & Beatty, 1985; Riley, 1979; Smit, 1952; Smith & Staudohar, 1954; Woolsey, 1985; 1986) have used it to investigate teaching and allied professions.

Today the technique fits comfortably into the action research paradigm first advocated by Lewin (1946) and subsequently refined by Kemmis & McTaggart (1982), Kolb (1984) and Carr & Kemmis (1983). It is often used as a means of gathering data in this type of research but it can also stand alone as a research method. In recent years, Tripp (1993) applied the technique in an effort to define and promote professional judgement among schoolteachers. Christie & Young (1995) also published a report on the use of critical incidents in vocational teaching and a subsequent study (Christie, 1998) described the value of the technique in the development of reflective teachers. Too often such research took for granted the everyday definition of terms like teaching profession or professional judgement. This paper argues that the language used in framing research questions and reporting results needs to be context-based.

## DESCRIPTION OF THE STUDY

The design of the research was simple. One hundred teachers from diverse backgrounds and teaching situations were asked to recall a specific incident or moment from their recent teaching experience, to write it down and to critique it. In this research it was important not to place a particular value on the remembered moment--it could be dramatic or non-dramatic, momentous or trivial. It was the critique of the moment by the participants that mattered.

The teachers involved in the research were introduced to Mezirow's (1991) theory of transformative learning and the notion of paradigmatic, casual and prescriptive assumptions, the assumptions that underpin an individual's view of the world. Mezirow calls these assumptions "habits of the mind," a phrase that resonates with Bourdieu's (1977) term "habitus."

The teachers were also encouraged to consider the assumptions that underpinned the structure of their

organizations. Most of these institutions were situated in Darwin, the capital city of Australia's Northern Territory, although some were located in that state's regional centers. The sites included a university, a college for indigenous students, a college for police and emergency services personal, a staff development center in a large hospital, a rural college and a number of vocational education centers.

There were clear differences both between and within these institutions. The Aboriginal College, for instance, catered exclusively to indigenous people. The Police College on the other hand, accepted recruits from different ethnic backgrounds but had other criteria that excluded certain individuals. The university had evolved from a community college. It was unique in Australia in that it had a higher education sector and a vocational education sector located on the same campus. These sectors awarded different degrees, had a separate course structure and used different teaching methods.

The diverse nature of the institutions enabled the researcher to compare and contrast how individual lecturers, with their own particular philosophies, theories of practice and beliefs acted within a prescribed field. Bourdieu argued that:

> The relationship between habitus and field operates in two ways. On the one side, it is a relation of conditioning: the field structures the habitus, which is the product of the embodiment of imminent necessity of a field (or a hierarchically intersecting set of fields). On the other side, it is a relation of knowledge or cognitive construction: habitus contributes to constituting the field as a meaningful world, a world endowed with sense and with value, in which it is worth investing one's practice.
>
> (quoted in Grenfell and James, 1998, p. 16).

Field can refer to a number of things--the field of teaching, the student's field, the subject taught or the institutional field. Habitus and field were not studied separately. Rather the researcher sought patterns of meaning that related to them from within the teacher's texts. The "moments"' they described indicated that what happened in those sites depended on a complex interaction between teacher and students, students and students and some times between those engaged in teaching and learning and ancillary staff, administrators and industry partners.

## FINDINGS

***Negative Nature***. One of the most surprising findings was that almost all of the moments described by teachers were of a negative nature. Although past studies have focused on "problems in teaching," the teachers in this study had been asked simply to remember an event or moment from their recent teaching. The fact that 90% of the incidents could be categorized as some form of negative experience was significant and worthy of further research.

***Classroom Management***. What was equally surprising was that 80% of all the incidents described could be categorized broadly as an issue of classroom or learning management. In other words the teachers tended to remember a moment when their authority was questioned or challenged. The challenge occurred in different forms and different aspects of the teacher's authority were challenged.

In a number of cases the challenge consisted of students refusing or consistently failing to do required work. At other times it was manifested as an outright disagreement over a teacher's explanation or demonstration. In some cases it was the method of learning that was queried.

In quite a few instances the challenge was indirect--students ignored clearly stated or generally accepted rules and the teacher was left with the dilemma of overlooking the breach of regulation or doing something about it. Some of the clearest examples of this occurred in settings where the rules involved health and safety regulations in workshops or laboratories. In other cases the challenge related to time--students came to class late or missed class altogether without offering a reasonable explanation.

In some instances there were problems between the students themselves and in these cases the teachers involved worried about their capacity to resolve them. They assumed it was their duty to do so in order to facilitate learning and considered that failure on their part would undermine their authority as a teacher. A variation of this latter problem was that some teachers taught subjects that dealt with controversial issues and they had difficulty mediating strongly held but conflicting points of view. This situation was compounded by the fact that the Northern Territory is made up of many different cultures, including a strong Aboriginal culture. Over 25% of the total population is Aboriginal and race prejudice was often an issue.

The teachers' reflection on their particular incidents revealed perceptions of their own habitus and the way it related to the field in which they worked. In some instances there were clear examples of the field structuring the individual habitus while in others it could be seen how the field itself could be changed from within.

***An Example***. A policeman, whose habits of mind had already been challenged and changed by the teacher-training course in which he was enrolled, related an apparently trivial moment from his teaching. He was lecturing a class of recruits about the laws relating to arrest when he noticed one of his students had slipped his shoes off. His dilemma was whether to discipline the recruit or ignore his behavior and continue

with the class. The instructor decided to continue but in his analysis he felt that he had made a mistake. He believed that his failure to admonish the student would suggest that rules could be broken with impunity. He also felt that his lack of action undermined the ethos of the Police College where clear rules and unquestioning obedience to them was the basis of training.

The text revealed a large amount of doubt and confusion. As a teacher trainee, subject to the influence of a different field, he felt that a public dressing down in the middle of a class would be "bad teaching" especially if his assumption that the student's action was a challenge to his authority was wrong.

The teacher training courses in which the research participants were enrolled had no specific module to deal with the issue of classroom management. Course designers argued that teaching situations varied so widely that general prescriptions were useless. This collection of incidents demonstrated that there were common elements and issues involved and that a course, which dealt with them, was possible.

***Contested Space***. According to this researcher any learning environment, by virtue of the purpose it has and the people who inhabit them, constitutes a "contested space." The lecture theatre, the classroom, the laboratory, the workshop, the syndicate room are sites where habitus and field intersect and sometimes collide. Common sense notions of what these spaces are and what occurs in them are misleading.

The nature and the degree of the contest depends on a number of things--the educational institution and the values it holds, the physical configuration of each teaching and learning space (often determined by the former) and the habitus of those who administer, teach or learn in that space. In this research, incidents involving verbal challenges to the teacher almost always occurred in a space designed or

rearranged for human interaction. In spaces designed for more traditional transmission forms of learning the challenges tended to be non-verbal. In workshops or laboratories where the space was designed for students to practice theory or skills, conflict mainly occurred when the teacher left that space unsupervised for a period of time.

## CONCLUSIONS AND RECOMMENDATIONS

Teaching and learning does not occur in a vacuum. It is strongly affected by the field in which it occurs, whether that field be the educational institution itself, the subject taught, the site of learning, the professional body of teachers responsible for designing and delivering the courses or the student body. It is affected by the habitus of the individual teacher and the individual student.

This research highlighted the way in which habitus and field can collide in a teaching and learning environment. Most teachers remembered negative moments in which their authority was challenged. Most of them, in their analysis of the incidents, uncovered assumptions that they did not even realize they held. This researcher argues that this is because all is not as it seems in a lecture theatre or a classroom. Too little thought has been given to the way in which individual college teachers are shaped and structured by their various fields.

Most of the critical moments in this study focussed on challenges to the teacher's authority. Teachers who believed they were "there to teach" were confused by the fact that the socio-cultural field that once invested teachers in the west with a large amount of authority has changed. College faculties and teacher training institutions have not always kept pace with such change and further research into "mapping the field" of college education might indicate useful ways of doing this.

## REFERENCES

Bourdieu, P. (1977). *The outline of a theory of practice*. Cambridge, UK: Cambridge University Press.

Bourdieu, P. (1990). *The logic of practice*. Oxford, UK: Polity Press.

Bourdieu, P. (1991). *Language and symbolic power*. Oxford, UK: Polity Press.

Bourdieu, P., & Passeron, J. C. (1979). *The inheritors, French students and their relation to culture*. Chicago: University of Chicago Press.

Bourdieu, P., Passeron, J. C., & De Saint Martin, M (Eds.). (1994). *Academic discourse*. Oxford, UK: Polity Press.

Brookfield, S. (1990). *The skillful teacher: On technique, trust, and responsiveness in the classroom*. San Francisco: Jossey-Bass.

Brookfield, S (1991) *Becoming critical thinkers: Learning to recognize assumptions that underlie ideas and actions*. San Francisco: Jossey-Bass.

Brookfield, S. (1995). *Becoming a critically reflective teacher*. San Francisco: Jossey-Bass.

Carr, W., & Kemmis, S. (1983) *Becoming critical: Knowing through action research*. Geelong: Deakin University Press.

Christie, M. (1998). The use of critical incidents in teaching and learning. *Conference Proceedings, Teaching and Learning Conference.* Darwin: Northern Territory University TLDO.

Christie, M., & Young, R. (1995). *Critical incidents in vocational teaching.* Darwin: Northern Territory University Press.

Corsini, R. J., & Howard, D. D. (1964). *Critical incidents in teaching.* Englewood Cliffs, NJ: Prentice Hall.

Domas, S. (1950). *Report of an exploratory study of teacher competence.* Cambridge, MA: New England School Development Council.

Flannagan, J. (1954). The critical incident technique. *Psychological Bulletin, 51*(4), 327-358.

Grenfell, M., & James, D., et. al. (1998). *Bourdiev and education. Acts of practical theory.* London: Falmer Press.

Jensen, A. (1951). Determining critical requirements for teachers. *Journal of Experiential Education,* 20, 79-86.

Kemmis, S., & McTaggart, R. (Eds.). (1982) *The action research planner.* Geelong: Deakin University Press.

Killen, R., McKee, A., Macleod, G., & Spindler, L. (1983). *Critical incidents in TAFE teaching.* Cardiff, UK: Newcastle College of Advanced Education.

Kolb, D. (1984). *Experiential learning.* Englewood Cliffs, NJ: Prentice-Hall.

Largravier, S., & Beatty, P. (1985). Practice what you preach: Using critical incidents to involve participants. *Conference Proceedings*. Milwaukee: National Education Conference.

Lewin, K. (1946). Action research and minority problems. *Journal of Social Issues*, *2*, 258-384.

Mezirow, J. (Ed.). (1990). *Fostering critical reflection in adulthood: A guide to transformative and emancipatory education*. San Francisco: Jossey-Bass.

Mezirow, J. (1991). *Transformative dimensions in adult learning*. San Francisco: Jossey-Bass.

Riley, M. (1979). The identification and validation of critical incidents in classroom discipline and their solutions as reported by first year vocational teachers in the state of Florida. *Conference Proceedings*. Tallahassee, FL: Annual Convention of the American Vocational Association.

Smit, J. (1952). A study of the critical requirements for instructors of general psychology courses. *University of Pittsburgh Bulletin*, *48*, 279-284.

Smith, R., & Staudohar, F. (1954). *Technical requirements of basic training for tactical instructors*. (USAF Human Resources Research Center, Technical Report, no 54-7) Washington, D.C.: USAF Human Resources Research Center.

Tripp, D. (1993). *Critical incidents in teaching, developing professional judgement*. London: Routledge.

Woolsey, L. (1985) Women's networks: Strengthening the bonds between women friends and family. *Conference Proceedings*. Saskatoon: Canadian Research Institute for the Advancement of Women.

Woolsey, L. (1986). The critical incident technique: An innovative qualitative method of research. *Canadian Journal of Counseling*, 20(2), 242-255.

# PARADIGM SHIFT:

# VISUAL COMMUNICATION

# AND EMPOWERMENT

**Daniel J. Doyle**
*Pennsylvania College of Technology*

## INTRODUCTION

Fundamental change does not occur at the stroke of midnight. The "digital age," with its emphasis on visual images, rests on nearly two hundred years of technological inventions extending from the birth of photography in the 1830s, through innovations in printing technology in the late nineteenth century, to developments in the late twentieth century in digital technology (Lubar, 1993). All these developments have contributed to the creation of an intensely visual world.

Walter Ong's (1982) analysis of the paradigm shift from oral to literate culture demonstrates the importance of careful analysis of other changes in the basic pattern of communication. Barry (1997) and Messaris (1994), along with Kress & van Leeuwen (1996) are among those who offer insights into the perception and structure of images as a visual language as well as the power of images to affect the mind regarding perceptions of reality.

The implementation of digital images (motion and still) in educational media offers considerable opportunities as well as obstacles for the teaching and learning environment. The challenge of developing a distance education course (HIS 262-

-Technology and Society)shaped instructional design aimed at extending student understanding both through and about images as language.

Images can be a curse or a blessing. Neil Postman (1985) criticized the use of image as entertainment and entrapment. On the other hand, Howard Gardner's (1983) theory of multiple intelligence stresses the importance of linking the "verbal and imagistic codes." Trachtenberg (1989) and O'Connor (1988) provided insight into the potential uses of images as part of the historical record.

## INSTRUCTIONAL DESIGN AND THE USES OF IMAGES

Images can be powerful resources--for example, when used to provide students with a context for course subject matter and readings. Computer-aided instruction in the 1980s focused primarily on text largely because the instructional paradigm was text-focused and computer technology had limited capacity for images. The development of multimedia and the networking of computers enabled course designers to employ visual elements in course material and to create independent learning modules to replace traditional lecture-based instruction.

The instructional development team, including the author, at the Pennsylvania College of Technology's Distance Education Office, planned to provide a visually enriched learning environment in offering HIS 262--Technology and Society. The course development plan enabled all involved the opportunity to assess the course in the light of nearly ten years of on-campus teaching of this same course. A previously developed course module--a hypertext "electronic chapter" for study of the British Industrial Revolution--demonstrated the value of providing a visual context (Doyle, 1995). The desire to provide students with a visual context was a high priority.

Fresh consideration was given to appropriate uses of the visual image and to ways in which students could begin to consider the image as evidence for both the historical record and for reflection on the emerging visual world of the last two centuries resulting from changes in information technology. The course's own delivery mode, at times, became part of the subject for reflection. The course content eventually constituted 14 lessons (chapters) totaling nearly 800 frames with approximately 90 percent of the frames containing an image (graph, map, movie clip or photograph). The images were utilized when content suggested the inclusion of appropriate and varying types of support.

Images serve as symbols with layers of meanings. A primary function for an image is to act as an identifier for an unknown or unfamiliar. The image in this case can also serve as a mnemonic device wherein the unfamiliar acquires meaning through association with an image. Thus a "spinning jenny" acquires added meaning with a picture of the textile machine wherein shape, dimension and some structure are conveyed along with composition and arrangement.

Maps and photographs establish opportunities for student consideration of relationships whether ones of the proximity of subjects or juxtapositions as a photo of children gathered in a tenement courtyard in 1900. Old photographs establish an immediate sense of history as the content and form project an immediate difference from the present. An early film, such as a New York City street in the late 1890s, conveys to the present day viewer the immediate sense of passage of time. Props (such as clothing and vehicles) and the very nature of the jerky, black and white images of the short film project a clear message of change.

Images offer opportunity for direct analysis as would any reading assignments in traditional text-dependent instruction. Propaganda images from the past hundred years are more easily recognized by students for the manipulation

contained therein. Such evidence can effectively prompt awareness in the power of images as well as offer opportunities for reflection and commentary pertaining to present day propaganda of a variety of types including economic and political persuasion. Images can serve as a direct subject for analysis such as graphs displaying trends or images of particular settings such as individuals standing before a sod house in North Dakota around 1900.

## RESPONSES TO THE VISUAL CONTEXT

The course design included a collaborative learning approach that employed considerable emphasis on the use of the course listserv. Numerous prompts were provided throughout the CD-ROM calling for *Post your thoughts to the listserv using the subject heading (word(s) reflective of the subject).* A button, which provided direct link to the listserv, was present on every screen of the CD-ROM content. Twenty students generated over 800 messages to the listserv in one semester.

The response to the North Dakota sod-house photograph during the first semester of implementation demonstrated the need for and advantages of visual analysis in a collaborative mode. The image of the sod house was purposely selected due to its stark features. Minimal evidence, at first look, would be present.

The subject matter under consideration was the altering influence of industrialization on agricultural life and work. The prompt for listserv discussion was *What evidence of industrialization can you find in this picture?* The first student response posted to the listserv was *Nothing.*

Over several days the discussion evolved to reflection on clothing and the pose of the four persons in the photograph. After prompts from the instructor to consider the seen and unseen, a student 'saw' a small pipe that indicated

the presence of a stove inside the structure. Once that observation was made, students quickly speculated about a number of aspects including the unseen camera and the cultural aesthetic. The absence of firewood prompted inquiries about fuel. The barren surroundings took on new meaning when prompted to probe and analyze.

Prior experience with a learning module for the British Industrial Revolution (Doyle, 1995) included focus-group assessment of the learning experience. Overwhelmingly positive student response was the primary motivator leading to selection of a visually enhanced approach to development of an entire course for computer-based learning.

Preliminary formative assessment conducted at the end of the fifth week of instruction confirmed the merit of such an approach. Other enriching factors included a course Home Page, chat room, a library Website tailored to support research relating to course assignments and electronic reserves containing chapters and articles selected from some of the bibliography listed for each course unit.

## CONCLUSIONS

A clear advantage for the use of images in computer-based instruction is that text in such a delivery mode has becoming increasing compressed. The cliché that 'a picture is worth a thousand words' has added meaning in the new instructional medium.

The disadvantage is that most people lack the visual literacy skills necessary to interpret the visual context. Lack of experience and passivity to the image requires attention to empowering students beginning with the need to probe images for content and meaning. The visible and invisible content merit observation and interpretation. The very understanding of the emergence of modern visual media over time both as history and through example in the evidence of the visual

record must be considered in all instruction that can or does employ images.

Cadava's (1997) observation regarding photographic pioneer William Henry Fox Talbot's characterization of his invention in the 1830s as "words of light" should prompt all involved in instruction in the digital era to ponder the many pitfalls and opportunities present regarding teaching and learning both with and about the image-based world.

Additional consideration must be given to empowering learners to conceive of images as visual language which requires the same level of critical analysis and evaluation given to written texts. Paulo Freire's (1970) emphasis upon basic text literacy as empowerment in a "community of learners" applies to visual language as well.

## REFERENCES

Barry, A. M. S. (1997). *Visual intelligence: Perception, image and manipulation in visual communication.* New York: State University of New York Press.

Cadava, E. (1997). *Words of light: Theses on the photography of history.* Princeton, NJ: Princeton University Press.

Doyle, D. J. (1995). An electronic chapter: The British industrial revolution. *Proceedings of the MacBeth National Conference: Computing in the Liberal Arts and Sciences.* Bethany, WV: Bethany College.

Freire, P. (1970). *Pedagogy of the oppressed.* New York: Herder and Herder.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences.* New York: Basic Books.

Kress, G., & van Leeuwen, T. (1996). *Reading images: The grammar of visual design*. London: Routledge.

Lubar, S. (1993). *Infoculture: The Smithsonian book of information age inventions*. New York: Houghton Mifflin Company.

Messaris, P. (1994). *Visual 'literacy': Image, mind and reality*. Boulder, CO: Westview Press.

O'Connor, J. E. (1988) History in images/images in history: Reflections on the importance of film and television study for an understanding of the past. *American Historical Review*, 93(5), 1200-1209.

Ong, W. J. (1982). *Orality and literacy: The technologizing of the word*. New York: Routledge.

Postman, N. (1985). *Amusing ourselves to death: Public discourse in the age of show business*. New York: Penguin Books.

Trachtenberg, A. (1989). *Reading American photographs: Images as history--Mathew Brady to Walker Evans*. New York: Hill & Wan.

# INTERACTIVE MULTIMEDIA:

# LESSONS FROM LEARNING THEORY

**Richard Farr**
*University of Nottingham, United Kingdom*
**Martin Barber**
*University of Salford, United Kingdom*

## INTRODUCTION

Interactive multimedia has the potential to offer improved teaching and to facilitate teaching in situations where it would otherwise be difficult, but the creation of suitable software can require substantial resources. Marshall, et. al. (1994) expressed development effort as a ratio of time spent in the software's creation to the time for which a student might typically use the end product, finding a consensus figure for multimedia development projects at around 300:1: This ratio implies that the "computerization" of even a single tutorial may require several weeks' work.

Marshall, et. al. (1995) found vendors' claims that each new release of multimedia authoring software promised increased productivity to be essentially meaningless, and Travis & Jones (1997) found that students' expectations from educational software continued to rise as a result of their experiences with home computer games. Consequently, development effort is a prime constraint when considering the creation of a piece of multimedia software, and it is vital to justify the considerable costs involved by designing software which will be as effective as possible.

***Learning Theory***. Learning theory is the term given to the work of educational psychologists who attempt to further

our understanding of how knowledge acquisition takes place. This may be used to improve instructional design. It is surprising to learn that many Computer Aided Learning (CAL) software developers do not have an appreciation of learning theory. Bhide and Nene felt that in CAL development "it is sufficient to be a good teacher" (Bhide and Nene, 1997, p.E4). Hudson (1984) warned that few developers appeared to be taking advantage of learning theory when designing their software, a view echoed by Bradshaw (1996)--and there is still a scarcity of papers on the application of learning theory to CAL and multimedia.

## DESCRIPTION OF THE STUDY

At the University of Salford, first year manufacturing students are required to study process planning, an activity in which an engineer examines the drawings for a product and determines which processes should be used for its manufacture. Originally, teaching of this subject was conducted conventionally--a one hour lecture was followed after a few days by a tutorial session in which students worked in small groups to develop a process plan for a simple turned part.

***The Problem.*** Although some students managed to complete the exercise with no difficulties, others required substantial assistance and in some cases still submitted process plans which, if put into operation, would have damaged a machine tool or possibly endangered its operator. The root of the problem was the style of the lesson. It was necessary to have the students working in small groups to ensure that everyone took part, but this meant the tutor could only spend a limited amount of time with each group. The tutor's role was primarily to interpret the students' process plans and describe any problems he foresaw. This was normally done through the

use of sketched *stage drawings*, each showing a sectional view of the workpiece as it took shape.

When a group of students came across a problem, or when they wanted their work evaluated, they had to wait until the tutor was free to provide feedback. Thus, much of the tutorial was spent waiting for assistance rather than working. The feedback which the tutor supplied was in a Socratic form, with the students being encouraged to hypothesize and the tutor acting to interpret their proposed process plans and introduce new questions as necessary.

***The Solution***. Since the availability of a tutor who could interpret process plans represented a limitation in a learning situation where the rules defining best practices were fairly easy to identify, the process planning exercise represented an ideal situation for educational multimedia to be employed. A package called "CAL3P"--Computer Aided Learning of Process Planning Principles-- was written and introduced.

***"CAL3P"--Computer Aided Learning of Process Planning Principles***. In addition to simply improving the instruction of undergraduate engineers, a goal of using the CAL3P software was to test the applicability of learning theory in interactive multimedia and the educational effectiveness of a variety of media. The multimedia author has a great many options when deciding how to present each fact, simply stating it in text, through the use of a diagram, or by shooting a short movie clip which illustrates the point. Whichever method is selected, each contributes towards the total amount of time required for software development, the requirements for specialist skills, and the minimum required computer configuration. It was felt that decisions which commit software developers to hundreds of hours of work would be easier to take once the likely effect of each medium's inclusion could be forecast.

Within CAL3P, extensive use was made of text and diagrams, but there were also photographs, video clips and animations. The authoring software employed was Asymetrix Multimedia ToolBook, though prototypes were originally developed in HyperCard. It was necessary to use a multimedia authoring environment which featured a powerful scripting language because of the high level of interactivity which was to be incorporated in CAL3P.

The software presented a process planning exercise in much the same form that it had taken when a human tutor was involved, but with the students able to type in a sequence of machining instructions and then see the resulting shape of the workpiece. Where before it had been the tutor's role to describe the motion of the machinery, this was now achieved by animation. Erroneous instructions such as a common mistake which causes the cutting tool to collide with the lathe chuck were brought to the students' attention when they ran the animation.

It is a significant feature of CAL3P that the animations are not generic, but based entirely on the students' own entries. While most educational multimedia packages present a "hardwired," predominantly linear learning experience, CAL3P could be reused or used in a different way simply by changing the photocopied part drawing which the students were required to follow. With a piece of multimedia software which can be reused without becoming dull and which can be adapted easily for use with students from a different age group, it is easier to justify the effort which must be committed to software development because a larger number of students can potentially benefit.

***Assessment.*** In order to assess the effectiveness of the software as a whole and each instructional technique within it, a built-in quiz was employed which students were required to attempt at the end of the session. Nineteen questions were used, in which students had to select appropriate techniques.

name pieces of equipment or enter machining instructions. Four of the questions in the built-in quiz deliberately tested for knowledge which could not be acquired from the software--in this way, students with a significant level of prior experience were identified. This was necessary because it would be unreasonable to state that a piece of software had facilitated learning simply because students gave satisfactory answers.

Students who were able to answer three or four of the "trick questions" correctly were considered to be experienced engineers and their results played no further part in the evaluation process. (With the assistance of tutors who knew the background of each student, this was subsequently proved to be true.) With quiz results from experienced engineers discounted, it was reasonable to assume that most of the remaining correct answers were brought about by the software itself. The percentage of correct answers to each quiz question could then be used to ascertain which forms of instruction had been the most effective.

## RESULTS

With regard to the general educational effectiveness of CAL3P, the standard of students' process plans had clearly improved since earlier years. The tutorial which had formerly required three hours of contact time was now accomplished comfortably in one and a half hours. These results were anticipated--the action of entering a process plan, running a machining animation and evaluating the result closely matched Kolb's (1974) model of learning as a cyclic process, which Yolles (1997) had suggested might be valuable within CAL.

With the computer supplying feedback as soon as it was desired, students supplying correct answers were rewarded with progress towards a correctly-shaped workpiece, a motivational process which educational psychologists such as Gagne (1975) called *reinforcement*. It

is also significant that students' responses to a questionnaire revealed that a substantial majority had found the computer-based exercise to be enjoyable and worthwhile.

With regard to the identification of which media were most effective, there was a substantial bias introduced by the context in which the media were employed. The level of interactivity which was required of the user was by far the most significant factor, outweighing the influence exerted by the choice of media. Students showed a mean 22.5% drop in performance when attempting to recall facts which had only been passively learned.

Results were in some cases surprising, particularly the very poor results observed where digital video had been employed. Indeed, there was an average 10% drop in recall performance when video formed a part of the lesson-- perhaps because video-based instruction requires only passive attention.

It had been expected that there should be some increase in student performance when video was employed. It is, after all, one of the principal arguments made in favor of the use of multimedia in education that a vivid presentation style should get a learner's attention and make experiences more memorable. Some authors, such as Heath (1996) consider digital video to be an indispensable constituent of multimedia, but experience with CAL3P suggests that the most effective CAL software need not feature the most technically demanding multimedia, by any means.

## CONCLUSIONS

Results obtained with CAL3P imply that learning theory can and should be applied to the design of CAL software, to ensure that the software is as effective as possible. Learning theory provides valuable advice on how to

establish motivation, how to pace a lesson, etc., all of which transfers perfectly well into the CAL domain.

Experiments with CAL3P showed that diagrams and animations offered the most memorable forms of instruction, though text remains the most efficient when development time is compared with recall performance. Of course, no single medium is universally applicable to all teaching needs, nor would a software package using a single medium qualify as multimedia.

Interactivity can almost be considered as a medium in its own right. Like photos, video clips or narration, it has its own "rules," its own associated costs and its own considerable impact on the quality of the learning process. Novak and Descharnais (1998) identified interactivity as the essence of the pupil/teacher relationship, but found current software implementations lacking. CAL3P shows how a high level of interactivity can increase the quality of instruction offered, and simultaneously make the software more suited to repeated use and use at other institutions. Either of these qualities may allow the project to achieve adequate payback for the development effort invested.

## REFERENCES

Bhide, S. R., & Nene, A. S. (1997). Some experiences in developing CAL packages for engineering education. *Proceedings of 3rd International Conference on Computer Based Learning in Science (CBLiS '97)*. Leicester, UK: DeMontfort University.

Bradshaw, M. (1996). The design of computer-based learning programs: A solution to the problem of reproducing teaching-learning acts through the computer interface. *Proceedings of the ALT Conference*. Glasgow, *UK*: Strathclyde Glasgow and Caledonian Universities.

Gagne, R. M. (1975). *Essentials of learning for instruction*. New York: Holt Rinehart & Winston.

Heath, S. (1996). *Multimedia and communications technology*. London: Focal Press.

Hudson, K. (1984). *Introducing CAL: A practical guide to writing computer assisted learning programs*. London: Chapman and Hall.

Kolb, D. A. (1974). *Organizational psychology: An experimental approach*. Englewood Cliffs, NJ: Prentice-Hall.

Marshall, I. M., Samson, W. B., & Dugard, P. I. (1994). Predicting the development effort of multimedia courseware. *Information and Software Technology*, 36(5), 251–258.

Marshall, I. M., Samson, W. B., Dugard, P. I., & Lund, G. R. (1995). The mythical courseware development to delivery time ratio. *Computers Education*, 25(3), 113–122.

Novak G. & Descharnais, R. (1998). Virtual courseware for science education: Virtual flylab and virtual earthquake. In J. A. Chambers (Ed.), *Selected papers from the 9th International Conference on College Teaching and Learning*. Jacksonville, FL: Florida Community College at Jacksonville.

Travis, L. C., & Jones P. D. (1997). From the classroom to the manufacturing workplace using multimedia tuition. *Proceedings of the 13th National Conference on Manufacturing Research.* Glasgow, UK: Glasgow Caledonian University.

Yolles, M. I. (1997). Learning style and strategy, and the theory of viable learning. *Proceedings of 3rd International Conference on Computer Based Learning in Science (CBLiS '97).* Leicester, UK: DeMontfort University.

# ASYNCHRONOUS DISCUSSIONS, LEARNING COMMUNITIES AND PARTICIPATION OF STUDENTS AND FACULTY

**Charles Graessle**
*Olivet College*

## INTRODUCTION

In an effort to increase interdisciplinary and active learning experiences, some progressive colleges have embraced learning communities which bring together students and faculty from different disciplines to collectively study a common issue. While the structure of learning communities varies in the number of courses that are linked together, they share an emphasis upon the social and cooperative contexts of learning, as opposed to the individualistic and competitive contexts (Cross, 1998). Thus, learning communities typically address their chosen theme with discussions or small groups in which students and multiple faculty interact.

Recent studies have confirmed that benefits stemming from cooperative strategies--and learning communities, specifically--include improved knowledge, problem-solving (Johnson, Johnson, & Smith, 1998), retention, and social involvement on campus (Tinto & Russo, 1995). Their interdisciplinary nature and emphasis upon faculty-student and peer interaction also allow learning communities to implement several important features of what are commonly called the principles of good practice (Chickering & Ehrmann, 1996).

This study involved a practical experiment implementing a set of learning communities using

asynchronous internet discussion boards as the main vehicle for interaction. A key goal of this project was to create an environment that makes discussion equitable and accessible across gender and cultural boundaries. Up to 20% of students at this college are nontraditional, and there is skewed gender distribution which could easily allow men to dominate discussions and interactions with the instructor.

In traditional classroom discussions, gender inequities in participation often implicate instructor characteristics (Howard & Henney, 1998). The use of technology does not automatically remove these coercive factors: students use more words in on-line chats at the same time that instructors decrease word use (Rickly, 1999); women sometimes receive more on-line feedback by using male pseudonyms (Pagnucci & Mauriello, 1999); and women are more likely than men to drop out of on-line discussions when their comments are opposed (Wolfe, 1999).

Asynchronous discussion boards may improve gender equity in participation by removing an important limitation--time--which may provoke a competition for attention in a discussion.

## METHOD

### Participants

The study examined eight elective courses or course groups using Internet discussion boards as a course requirement in the last three years. Three of these were learning communities, involving students and faculty from two different major areas, and five were independent classes whose discussion boards only involved the students and instructor from one class.

### Design and Implementation

All students and faculty had access to two computer labs with T1 internet access. A Web site, available on the World Wide Web, was provided for each learning community and always featured one or more asynchronous bulletin-board style discussion areas. Instructors provided trigger questions to start a discussion that would occur over a period of a week or more (and were told by the students that they needed to participate in the discussion, too). As appropriate for the class, bulletin boards were created for small groups to discuss and draw a consensus on an issue or to organize themselves for a project.

## RESULTS

Participation was measured in terms of the total number of words used and by the total number of entries that were more than four minutes apart. The median total number of words and the median number of entries per student and for instructors was calculated for each course and for men and women separately for each course.

### Instructor Participation

*Number of Entries.* Faculty in learning communities typically posted three times more entries than faculty in independent courses (see Table 1).

**Table 1. Mean Number of Words Per Student By Gender and Mean Number of Instructor Entries in Asynchronous Discussion Boards in Eight Courses**

| | | Gender | | Number of |
|---|---|---|---|---|
| Course Format | N | Males | Females | Instructor Entries |
| Learning Community | 3 | 200.2 | 220.0 | 11.5 |
| Independent | 5 | 116.9 | 273.2 | 3.6 |

One hypothesis is that these learning communities attracted certain types of instructors, such as those who already were discussion-oriented; however, this probably does not explain participation rates in this study because some of the same instructors contributed data to both course formats in this study.

It seems equally likely that the dynamics involved in creating learning communities promote faculty participation because of professional social contact or increased intellectual stimulation.

***Relation to Student Participation.*** There were no other effects involving faculty participation variables. Neither number of entries nor number of words of instructors were systematically related to any student participation measures.

## Gender and Course Format

***Total Words Used.*** Median total number of words in each class was normalized with a square root transformation and then analyzed for the effects of course format and participant gender with a 2 x 2 repeated measures ANOVA. Women participated at rates as high as or greater than men. In addition, there was a statistically significant interaction between course format and gender: $F(1, 6) = 6.81$, $p = .04$. As shown in Table 1, women's word use was the same in both

course formats and was the same as men in learning communities, but men used fewer words than women in independent courses.

Data are still being collected which may determine whether accessibility is also improved for racial groups or nontraditional students. This continuing project also is examining cognitive outcomes related to interdisciplinary and critical thinking.

## DISCUSSION

This experiment has demonstrated the potential of the learning community format in combination with asynchronous Internet discussion forums to promote more equity in discussions. In contrast to data from live discussions, there were no effects of faculty over- or under-participation in this study.

More important to students' participation may be the conditions found in these classes. The asynchronous forums allowed students time to think about comments before posting them, perhaps increasing their confidence or courage. Because students do not compete for time, competitive argumentative strategies--such as wearing down competitors with words, interrupting others, or shifting the topic of conversation--are less effective. Finally, individual characteristics of these students, such as their exposure to principles of dialoguing and conflict resolution, may have helped create a discussion environment particularly safe for women.

Especially interesting is the positive impact of these learning communities on men's participation. The fewer words used by men in independent courses may reflect their need for more motivation to provoke writing. The presence of two professionals in a learning community discussion may provide that motivation by increasing the potential critical evaluation.

Alternatively, the interdisciplinary discussions may simply be more interesting to the male participants.

## REFERENCES

Chickering, A., & Ehrmann, S. (1996). Implementing the seven principles: Technology as a lever. *AAHE Bulletin, 49*(2), 3 - 6.

Cross, K. P. (1998). Why learning communities? Why now? *About Campus*, (July-August), 4 - 11.

Howard, J. R., & Henney, A. L. (1998). Student participation and instructor gender in the mixed-age college classroom. *Journal of Higher Education, 69*(4), 384 - 405.

Johnson, D. D., Johnson, R. T., & Smith, K. A. (1998). Cooperative learning returns to college: What evidence is there that it works? *Change, 30*(4), 27 - 35.

Pagnucci, G. S., & Mauriello, M. (1999). The masquerade: Gender, identity, and writing for the Web. *Computers and Composition, 16*, 141 - 151.

Rickly, R. (1999). The gender gap in computers and composition research: Must boys be boys? *Computers and Composition, 16*(1), 121-140.

Tinto, V., & Russo, P. (1995). Learning communities, collaborative learning, and the pedagogy of educational citizenship. *AAHE Bulletin, 47*(7), 11-13.

Wolfe, J. L. (1999). Why do women feel ignored? Gender differences in computer-mediated classroom interactions. *Computers and Composition, 16*(1), 153-166.

*Note:* Funding was provided by a 1999 Ameritech Partnership Grant to Olivet College for Internet-mediated Learning Communities in the Social Sciences.

# EDGE OF CHAOS: THE SWEET SPOT FOR INTERNET-RICH PEDAGOGY

**Barclay M. Hudson**
*The Fielding Institute*

## INTRODUCTION

In the next 100 years, classroom walls will crumble like the bastions of Jericho and Berlin. The idea of learning in silent, passive rows before a droning instructor will seem as strange as adults sitting in silent rows of international conferences listening to the drone of presenters. These venerable but bizarre practices will be swept away, just as during the last century the planes of Kitty Hawk gave way to the Mars landings.

Education is next in line for Big Changes. Not long ago, armies marched into battle shoulder to shoulder, the front ranks falling to the bullets, but most reaching their objective--a matter of acceptable losses. Machine gun technology changed that, shifting the whole concept of attack from close-rank marching to terrain-hugging mobile spearheads, camouflage, and mastery of the unconventional.Similarly, in education, the rows of static classroom seats may soon be functionally obsolete. Trained to sit in passive and stoic ranks before the withering hail of ideas from the front of the classroom, many students never reach the learning objective, but the losses have always seemed acceptable. Internet technology will change that. Some day soon, education will be a dispersed, Internet-embedded process, less like a one-room schoolhouse than a British university degree program--no

fixed classes, but simply a richness of intellectual wealth to feed a self-designed study program, nourished by the world's great libraries, and one-on-one discussions with virtual Nobel laureates.

True or crazy? The Internet doesn't care. Like the machine gun, it has come on the scene and big changes will follow. In the short run, Web-based information resources will serve as a tool within the classroom--a process already underway. But longer term, the learning walls will give way altogether, the learning process bursting out to be absorbed in the surroundings as a whole. This is already happening, in a way that educators tend to overlook, because it seems to be happening via the home computers that students use after school hours, while school are slower to connect up.

These trends can be examined by looking at the latest edition of *Wired* magazine or the *Chronicle of Higher Education;* or using historiography to extrapolate trends; or simply invoke the notion of paradigm shifts (Kuhn, 1962). This paper, however, takes a somewhat different route, by drawing on an analytical framework that has sometimes been described as "the science of surprise" (Casti, 1994), and which goes by the name of chaos theory, or complexity theory. (Bass 1999; Gleick 1987; Hall 1992; Lewin 1993; McClure 1998; Stacey 1992; Wheatley 1992;). Relevant concepts are briefly described below, but with special attention to the particular conditions that lie at the "edge of chaos" (Kauffman 1995; Waldrop 1992), conditions which are particularly favorable to creativity and change, but also to the mutual adjustment of coupled systems that are on the cusp of being either antagonistic or symbiotic. For purposes of integrating the Web with the classroom, the edge of chaos defines a narrowly bounded "sweet spot" for the symbiosis of two very different animals.

## A BRIEF TOUR OF CHAOS

In complexity theory, "chaos" has little similarity with its popular connotations of confusion, anarchy and randomness. On the contrary, the most compelling models of chaos are based on rigorously deterministic processes, often generated by mathematical formula. Yet the outcomes are surprising in a number of ways--they have major implications for management of change and for understanding the ways that change inherently defies management. Some examples follow.

***Non-Linearity.*** Chaos theory addresses the nature of change in non-linear systems, involving small changes that feed on themselves, sometimes resulting in massive changes. A familiar example is the "butterfly effect," whereby a whisper of air movement in one part of the globe can create growing eddies that are self-reinforcing and end as a hurricane somewhere else.

***Deterministic Unpredictability.*** Not only do infinitesimal variations become magnified and lead to unpredictably divergent outcomes, but there can also be shifts in the very nature of the engines that drive change. This can reflect the nature of scaling up (through bifurcation points) or the nature of phase shifts, seen for example in the transformation of water to ice or vapor, or the shifting gate of a horse from trot to canter. These shifts also arise through resonance between independent sub-systems that begin to interact loosely, eventually behaving like a single organism.

***Open-Systems and Closely Coupled Systems: Evolution as a Pas de Deux.*** Finally, no system operates in isolation, but responds to its environment. Just as beavers build dams, systems can create their own environment and make use of it to accelerate the path of their own evolution, bringing into play various other phenomena depicted by chaos theory, under such headings as "lock in," "fitness

environments," "closely coupled systems," "autocatalysis," and "autopoiesis." Many of these processes are already at work in the evolving interface between education and the Web

## EVOLUTION REQUIRES STABILITY, TOO

With all this emphasis on non-linearity, unpredictability and change, it is easy to lose sight of the other half of chaos theory, which is its power to explain stability and persistence of pattern. When people talk about the role of DNA in evolution, they tend to focus on genetic malleability, while overlooking one of the most remarkable features of DNA--namely its extraordinary stability. DNA faithfully transmits hundreds of thousands of messages from one generation to the next, while preserving the basic language of the genetic code intact over literally billions of years of evolution.

In the same way, chaos theory reveals a surprising capacity of systems to maintain stability in the face of turbulence. Included here are the notions of "strange attractors"--manifested in the appearance of stable patterns that persist in the cycles of changes, despite the unpredictability of each moment's behavior. Such patterns are seen in stable or recurrent structures found in water flow from faucets, in weather patterns, in fractiles (which are self-similar but never exactly alike from one scale of pattern to the next), and in the phenomena of resonance, lock-in, intermittency and bifurcation points.

All these elements lead to certain recognizable patterns of emergence that arise in self-organizing systems. And the Web is a classic example of a self-organized system as described by chaos theory (Coveney & Highfield, 1995). These basic, naturally occurring structures described in chaos theory are far from obvious, not only because they transcend (and lie unseen beneath) the separate academic disciplines, but

because the whole idea of self-organizing systems is based on "order for free," as Kauffman (1995) puts it. This flies directly in the face of the older notion of entropy, whereby only human planning and intervention can bring order to a world that--left to its own devices--would fall into decay and disarray.

Chaos theory has met with initially severe resistance in every discipline where it has been applied-- from physics to biology, math, economics, anthropology, psychology and business management--but it has steadily overcome objections and proven to be more than simply a nice metaphor. In fact, some of the leading theorists in the field have developed chaos theory applications to stock market predictions models that are proving very successful, with funding from some of the world's largest investment banks (Bass 1999).

## "EDGE OF CHAOS" AS THE EVOLUTIONARY SWEET SPOT

One final and vital concept of chaos theory bears directly on the issue of educational adaptation to the challenge of Web-based learning. This is the concept of edge of chaos conditions--the state where a system is suspended between too much turbulence and too much rigidity. Here, there is a strong enough fixed structure for the system to maintain itself under turbulence (like the unchanging spine of a DNA molecule), but sufficient degrees of freedom for change to happen, like the shifting of nucleotides that form the ladder rungs between the two strands of the DNA helix.

As Kauffman puts it, the edge of chaos is "a compromise between order and surprise," (Kauffman, 1995, p. 26), a place that allows both spontaneous evolution and continuity that builds on past successes. In the context of biological networks, he finds these edge of chaos conditions as the place where networks "appear best able to coordinate complex activity and best able to evolve as well." (Kauffman,

1995, p. 26). Moreover, these conditions allow co-evolution of partner systems: a predatory relationship can evolve toward a symbiotic one, provided there is enough stability for each partner to learn and adapt, plus sufficient flexibility to handle mutual adjustment. (Kauffman, 1995).

Kauffman's (1995) research demonstrates that there is a narrow band of criticality at work here--to co-evolve, the relationship must be neither too tightly coupled, which suppresses evolution, nor too loosely coupled, which makes them uselessly unresponsive to each other. At just the right level of connectedness, each small change cascades into other changes, in a process of mutual adaptation. Once started, the process can take off very quickly--a phenomenon seen in the fits and starts of evolutionary divergence, in mathematical models of complexity events (at bifurcation points), and even in historical processes that we have witnessed, such as the surge of interest in science in American schools during the 1960s, after Sputnik.

## A SPECIFIC EXAMPLE OF WEB-CENTRIC HIGHER LEARNING

This paper is not aimed at any sort of blueprint--in fact, that would be quite antithetical to the whole idea of self-organized criticality and the kind of "emergence" sought. In fact, a chief lesson of chaos theory may be the need to let go of strategic blueprints, and to work instead on reinforcement of small beginnings that seem to be moving in the right direction.

One small beginning is the Fielding Institute in Santa Barbara, or more specifically the Master's Program in Organizational Design and Effectiveness (ODE).The ODE program offers a seminar in chaos theory applied to leadership, group processes, organizational design for change and management of turbulence in the context of globalization-

-a seminar taught by the author of this paper. This program, now in its fourth year, was designed to work specifically for learning through the Internet. Intensive face-to-face sessions take place at the beginning of the 20-month program and again halfway through the process (when masters thesis projects get underway). Otherwise, assignments consist of a highly structured series of on-line dialogues, involving students (and faculty) ranging from Belgium to Hong Kong and South Africa to Alaska.

Fielding operates this dialogue in a completely asynchronous mode, each person posting and responding in a flexible window to accommodate widely varying time zones as well as personal work schedules--the majority of these students being mid-career adults. Surprisingly, the effect is to make the other person's presence more immediate, not less. Replies tend to be in a spontaneous and vernacular tone (a deliberate avoidance of dry academic prose), but the personalized "voice," when composed in asynchronous mode, has room for thoughtfulness and second thoughts as well.

Often, the first instinct of distance learners is to want more contact, and the normal impulse is to use real time media--a telephone conference call, a chat room, a time-specific event--to restore the sense of doing something together. But based on experience in the Fielding program, this is a mistake. Another temptation is to develop multi-media communication channels that supplement text with sounds, visuals, and other document enhancements. But here too, less is more. In this author's opinion, the power of a text lies partly in the starkness of words, without distractions. Like black and white photography, attention is shifted to specific features, demanding greater intentionality.

## ASYCHRONOUS COMMUNICATION: ENHANCING THE EDGE OF CHAOS

Two conclusions are drawn from this discussion. First, the positive assessment of asynchronous learning devices, however subjective, may have a more objective basis in the notion of edge of chaos conditions for creative co-evolution. The speaker and listener (writer and reader) have a sense of immediate connectedness, timed to their own situation and context, yet they are loosely coupled in a way that is quite different from traditional classroom practices, where each member of the audience must be on the same page at the same moment, in lock-step according to the lesson plan and the lecturer's train of thought.

Secondly, the shifting of the center of gravity of the dialogue--from instructor to self-organized topics and issues generated by the learner--has a deeper resonance with the intellectual movement now beginning to emerge under the heading of "decentralized intelligence." In part, this movement reflects the shift of authority from top-down, centralized institutions to highly dispersed groups and individuals. In part, it reflects deliberate strategies to make institutions more responsive to the variety of real world conditions and their increasing pace of change. As Shelley Hamilton has noted:

> Information can be centralized because it is just quantitatively categorized bits of data. But knowledge needs to be decentralized because it is the experiential interpretation of that information, and experience is relationship based-- thus decentralized.
>
> (Shelley Hamilton, personal communication, Nov. 29, 1999).

This notion of decentralized intelligence has made an appearance in the literature of strategic planning and human resources training programs, among cutting edge business and public sector organizations alike. Even the U.S. Army has committed to a radical shift away from older ideas of centralized command, control and intelligence. Here, the issue becomes one of managing massive amounts of information and resisting the temptation to over-control it. The competitive advantage is nullified when you try to run decisions up and down the chain of command.

> [Everyone has] real-time information on what is going on around them ... [so] once the commander's intent is understood, decisions must be devolved to the lowest possible level to allow these frontline soldiers to exploit the opportunities that develop.
> (Pascale, Millemann, & Gioja, 1997, p. 134)

In this new era, leaders are trained to learn to live with the ambiguity and discomfort of "leading from a different place" by refusing to provide all the answers to the troops. Instead, they allow a stressful vacuum of answers to develop, until the troops learn that they must provide the answers themselves as well as the commitment to implement them.

Can educators sustain their own discomfort with that vacuum of answers? Can they live with a genuinely creative "edge of chaos" within schools? And can educational institutions go even farther, to promote those edge of chaos conditions in a growing symbiosis of learning opportunities made possible by the Web, outside the classroom walls? The question is really not whether, but how soon.

## REFERENCES

Bass, T. A. (1999). *The predictors*. New York: Henry Holt.

Casti, J. (1994). *Complexification. Explaining a paradoxical world through the science of surprise*. New York: Harper Collins.

Coveney, P. & Highfield, R. (1995). *Frontiers of complexity*. New York: Faucett Columbine.

Gleick, J. (1987). *Chaos: Making a new science*. New York: Viking Penguin. (Paperback. Q172.5C45G54)

Hall, N. (Ed). (1992). *The new scientist guide to chaos*. London: Penguin Books.

Kauffman, S. (1995). *At home in the universe: The search for laws of self-organization and complexity*. New York: Oxford University Press.

Kuhn, T. (1962). *The structure of scientific revolutions*. Chicago: University of Chicago Press.

Lewin, R. (1993). *Complexity: Life at the edge of chaos*. London: J.M. Dent.

McClure, B. A (1998). *Putting a new spin on groups. The science of chaos*. Mahwah, NJ: Lawrence Erlbaum.

Pascale, R, Milleman, M., & Gioja, L. (1997). Changing the way we change. How leaders at Sears, Shell, and the U.S. Army transformed attitudes and behavior--and made the changes stick. *Harvard Business Review, 75*(6), 126-139. [HBR reprint #97609]

Stacey, R. D. (1992). *Managing the unknowable: Strategic boundaries between order and chaos in organizations*. San Francisco: Jossey-Bass.

Waldrop, M. M. (1992). *Complexity: The emerging science at the edge of order and chaos*. New York: Touchstone Books.

Wheatley, M. J. (1992) *Leadership and the new science*. San Francisco, CA: Berrett-Koehler.

# PEER CRITIQUES

# IN THE TEACHING

# OF COMPUTER PROGRAMMING

**William J. Joel**
*Western Connecticut State University*

## INTRODUCTION

Traditionally, in courses for which programming exercises are a major component, students are often required to submit programming assignments to either the instructor or assistants, to obtain comments and/or a grade. In this manner, students receive appropriate and valuable feedback from individuals for whom programming is an already acquired skill. What students do not receive, in this scenario, is a deeper understanding of either where they are with respect to their own learning curve, or where they are with respect to other students in the class. What students are missing are critique from their peers to augment the critique they receive from their instructors.

In the arts, a peer-critique is a well-established tool for providing students with ample feedback regarding their progress, at each stage in the creation process. Students are often asked, in art classes, to display their work, completed or in-progress, to both their instructor and their fellow classmates. From these critique sessions students gain a better understanding of how their work is viewed and interpreted by others. In addition, students are exposed to a wide variety of approaches to solving common problems. This last aspect of peer critiques is what Computer Science students, as new

programmers, require the most. Beginning programmers need to see not only finished products as presented by their instructors, but also the works-in-progress of their fellow classmates.

In this paper, the author will first present how peer critiques have been integrated into his programming classes, not only at the beginner level, but in advanced classes as well. Second, student feedback with respect to these strategies will be discussed. Lastly, the aspects that appear to be most successful will be examined and recommendations provided on how to extend the use of peer critiques in programming classes.

## VARIATIONS ON A THEME

### The Peer-Critique Process

During a computer science class, either a lecture or a lab session, the author often presents students with a problem that they are asked to solve by first creating an appropriate algorithm and then translating this algorithm into an executable program. Students are often grouped into ad-hoc teams consisting of two to four students. Students are also given a time frame within which they are expected to complete this assignment, though the allotted time is often extended if a sufficient number of teams require the extra time.

At the end of this time period, each team is asked to submit printouts of all the source code files they wrote for their program, whether or not they have completed the assignment. These printouts are taped to the classroom's whiteboard along with a *Critique Sheet*, which is merely a single sheet of widely, lined paper with the word "Comments" printed at the top. Next, each team is asked to send one of its members to the board to comment on, in writing, the work of

one of the other teams. Again, students are given a somewhat fixed time period within which to complete this critique.

After the student evaluations are completed, each team is asked to remove their printouts from the whiteboard along with the comment sheet for their work as filled out by another team's member. Each team is then asked to review these comments to determine first whether or not they agree with the comments made concerning their work, and second, what they learned from the entire process. This last component is critical to the success of the peer-critique exercise in that it provides students the opportunity to be more fully engaged in the process of computer-based problem solving. Or, according to Bloom's Taxonomy (Bloom, 1956; Krumme, 1999), to reach the cognitive level of *evaluation*.

**Appropriate Topics**

In order to insure the success of a peer-critique exercise, the nature of a lesson's topic(s) needs to be addressed. Some topics lend themselves naturally to peer comments while others do not. Those topics that are technical in nature, such as the specific syntax for a given control structure (Example: The if-the-else structure in C++) are not areas that of themselves easily form the basis of a peer-critique exercise. They are tools that are used to create a final, executable program but do not necessarily impact upon the nature of computer-based problem solving.

On the other hand, a discussion of branching and decision structures, in algorithms and programs, is an appropriate topic for a peer-critique exercise. An exercise based on this topic requires students to not only understand and comprehend decision structures and their use, but also to be able to apply this understanding in the development of an appropriate solution for an assigned problem.

**Scope of Exercises**

Also, with respect to topics suitable for a peer-critique exercises, the relative quantity of new knowledge students are being asked to apply needs to be considered. Problems based on new topics need to be well defined and solvable within a reasonable amount of time. The scope of an assignment needs to be established which permits students to have sufficient time during a class session to not only complete the programming part of the exercise but to also engage in peer-critiques.

**Examples**

Consider the previously mentioned topic of decision structures. A problem statement that could entail too much classwork on the part of student teams might read:

*Problem: Develop a program that will allow a meteorologist to determine whether or not it will rain later in the day.*

This problem is not suitable to a classroom exercise, let alone a peer-critique exercise, in that it would entail students to perform research as to how weather predictions are made, and then craft a suitable algorithm and program.

On the other hand, a problem that has been assigned in classes is:

*Problem: Develop a program that will allow a user to determine what articles of clothing to wear based on current weather conditions.*

This second problem does not require students to become mini-meteorologists. Rather, it utilizes strategies and concepts with which students are quite familiar, but then asks

them to take these strategies and represent them first in the form of an algorithm and second as a program. It is also a problem for which the majority of students (if not all) begin with a common knowledge base. This last element also helps to insure success in the peer-critique phase of the exercise by insuring a common background from which to generate each critique.

**Guidance**

During the peer-critique phase for a given exercise, it is important to first prepare students by clearly stating specifically what they are being asked to comment on, and how to perform this critique. The following are guidelines the author verbally states when students are asked to perform a peer-critique.

*You may comment on...*

- The semantic elements of the program: specific methods, identifiers, program organization, etc.
- The syntactic elements of the program.
- The visual elements of the program: readability, identifiers, layout, indentation, line spacing, etc.
- Any other elements you deem important.
- You may write your comments either on the source code printouts or the comment sheet, or both.

These guidelines are just that, guidelines and not rules. They provide a framework for successful peer-critiques in that they are neither so vague that students would not know where

to start, nor are they so rigid that the process would become formulaic.

## DISCUSSION

The author has successfully used peer-critiques in courses at several levels over the last year and a half. For the most part, students have found the process to be both engaging and informative, They have seen not only how the instructor approaches problem solving, but also how their peers approach it.

This is not to say that students have not had negative feedback. One student in particular related growing tired of class project teams. The student stated that these teams often spent a good deal of time simply figuring out where to start, and therefore would have preferred to complete the exercises independently.

The lesson the author learned from this feedback was that simply shuffling the teams from one in-class project to another was not enough. Some students work very well on their own and feel hindered when asked to work as part of a team. Learning team strategies is an important objective for students, in the author's opinion, but the need for individual work must also be recognized. As such, the author has begun to ask students, on occasion, to complete a given exercise by themselves and not in a team. In time, it will be seen whether or not this approach works well with peer-critiques for programming.

Also, at present, students are not asked to display their handwritten algorithms on classroom whiteboards, merely their final programs. In the future students will be asked, on occasion, to display "works-in-progress" to receive valuable peer feedback prior to the completion of a given exercise.

In order to accommodate larger problems in-class, the author has begun to use the strategy of assigning a problem

during one class session, and asking student teams to complete the assignment during the following session. This not only provides students the ability to work on larger problems in-class, but also gives students the time to reflect on their work between sessions. It is hoped to more fully integrate this multiple-session approach with peer-critiques in the future.

## CONCLUSIONS

Peer-critiques are as valuable in computer program development as they are in any problem solving exercise. As such, they provide students the opportunity to explore multiple approaches to solving a given problem within a well-defined amount of time. This exposure to multiple avenues of thought is critical to students' development as programmers as well as computer scientists, not only at the introductory stage of their development but also at the advanced stage. By incorporating peer-critique exercises in programming classes, faculty can provide students another tool to aid them in their educational journey.

## REFERENCES

Bloom, B. (Ed.). (1956). *Taxonomy of educational objectives.* New York: Longmans, Green.

Krumme, G. (1999). *Major categories in the Taxonomy of Educational Objectives (Bloom, 1956).* [On-line]. Available: http://faculty.washington.edu/krumme/guides/bloom.html

# ACTIVE LEARNING: STUDENT PERFORMANCE AND PERCEPTIONS COMPARED WITH LECTURE

**David A. Lake**
*Armstrong Atlantic State University*

## INTRODUCTION

Active learning is touted today by some authorities as a major factor in enhancing learning. But what do studies show? DaFosa and colleagues (1991) reported no difference in scores on exams between lecture based and active learning modules of a single course. Similarly, Goodwin and colleagues (1991) reported that basic biology courses with half lecture and half small group discussion were not well received by students, who felt that they had learned less than students in previous courses using only lecture and expressed concern about their perceived lack of basic biology knowledge. However, they performed the same on examinations in advanced courses as other students who had taken biology courses using the lecture format.

Conversely, Richardson and Birge (1995) reported that students in physiology course sections with active learning components scored higher than students in lecture only sections. They reported that students in these active learning course sections rated the course higher on standard teacher-course evaluations than students in lecture only sections.

Thus it appears that the issues of the value of active learning methods and student perception of active learning courses still remain unclear. The purpose of the present study was to compare student learning and student perceptions of course and instructor effectiveness, course difficulty and

amount learned in the course between a physiology course using a group discussion, active learning format and a physiology course using a lecture only approach.

## DESCRIPTION OF THE STUDY

The same physiology course was taught by the same instructor in the Fall and Winter Quarters to two different groups of students. This course was taught in the Fall Quarter as a lecture course with four, one-hour lectures per week. In the Winter Quarter, the physiology course was taught using an active learning format with a one-hour session for all students and a one-hour discussion session in groups of 15-20 students each. Students in both courses received weekly quizzes, a midterm exam and a cumulative final exam. The same course topics were presented in both courses, and the same readings were used. Both courses had the same study questions and all quizzes and examinations in both courses were of a similar format, content and difficulty.

The total points earned in both physiology courses were summed from the weekly quizzes, a midterm examination and a final examination. Final course scores were reported as percentages of total points possible in the course. The final course averages in the anatomy course which the students were taking at the same time for these two groups of students were also compared to investigate the academic equivalence of the two groups of students. The grades from the two terms were compared, and the statistical significance was determined using the Mann-Whitney U. The alpha level was set at 0.05.

Student perception of the instructor and overall course effectiveness, course difficulty and the perceived amount that the students had learned were measured with the standard teacher-course evaluation (1 to 5 Likert style scale with the 1 score being the lowest score). The teacher-course evaluation

results were compared between the lecture course and the active learning course. An analysis of student perceptions for each question on the evaluation from the two terms were compared and statistical significance was determined using the Mann-Whitney U. The alpha level was set at 0.05.

## FINDINGS

The physiology course grade average significantly increased from 79.4% in the lecture course to 83.5% in the active learning course (Table 1).

**Table 1: Comparison Of Final Average Percent Score For Both The Physiology And Anatomy Courses For Students Participating In The Physiology Lecture Course And Students Participating In The Active Learning Physiology Course.**

| Physiology | | | | Anatomy | |
|---|---|---|---|---|---|
| Teaching Mode | X | SE | p | Teaching Mode | X |
| Lecture | 79.43 | .87 | | Lecture & Lab | 82. |
| Active Learning | 83.49 | .70 | <.001 | Lecture & Lab | 81. |

There was no difference between the course grade averages of these two groups of students in gross anatomy with a course average of 82.0% for the group of students who received only lectures in physiology and 81.6% for those students who had the active learning course (Table 1).

As can be seen in Table 2, there were significant declines in the perception of the effectiveness of the course and the instructor by students in the active learning course

compared with the perception of students in the lecture course.

**Table 2: Comparison Of Student Perceptions Of The Amount Learned And Course And Instructor Effectiveness For The Lecture Course And Active Learning Course.**

| Evaluated Perception | Lecture | | Active Learning | |
|---|---|---|---|---|
| | X | SE | X | SE |
| Amount Learned | 4.46 | .09 | 3.61 | .12 |
| Course Effectiveness | 3.95 | .11 | 2.94 | .13 |
| Instructor Effectiveness | 4.39 | .10 | 3.16 | .13 |

Although the average grades were significantly higher in the active learning course than in the lecture course (Table 1), the students in the active learning course perceived that they learned less than those students who were taught by the lecture method (Table 2).

## CONCLUSIONS AND RECOMMENDATIONS

The present study had very interesting results. There was a significant increase in the student academic performance when compared to students in the lecture course. These results support the observations of Richardson and Birge (1995). who reported that students in physiology course sections with active learning components scored higher than students in lecture only sections.

However, the students in these active learning courses felt they had learned less than students in the lecture course. There was also a significant decline in the students' perceptions of course and instructor effectiveness. A large

number of the comments on the teacher-course evaluations among the active learning students were directed at perceived instructor effectiveness.

A very common statement was...*He did not teach me anything*. These results contradict those reported by Richardson and Birge (1995). In their study, students in these active learning course sections rated the course higher on standard teacher-course evaluations than students in lecture only sections. However, the results of this study support the results of Goodwin and colleagues (1991) who reported that basic biology courses with half lecture and half small group discussion were not well received by students, who felt that they had learned less than students in previous courses using only lecture and expressed concern about their perceived lack of basic biology knowledge.

The mismatch of student learning and their perception of how much they had learned in active learning courses was a major problem. In the present study, there was a significant decline in the amount that they felt they had learned in the active learning courses when compared with students in the lecture course. This was the students' impression despite the fact that their higher scores on examinations would tend to suggest they actually learned more. Methods must be developed to eliminate or reduce this mismatch of performance and perception.

## REFERENCES

DaFosa, D. A., Kolm, P., Follmer, H. C., et al. (1991). Evaluating the effectiveness of the lecture versus independent study. *Evaluating Progress and Plans*, 14, 141-146.

Goodwin, L., Miller, J. E., & Cheetham R. D. (1991). Teaching freshmen to think--does active learning work. *Bioscience*, 41, 719-722.

Richardson, D., & Birge, B. (1995). Teaching physiology by combined passive (pedagogical) and active (andragogical) methods. *Advanced Physiological Education*, 13, S66-S74.

# IMPROVING TEAM PERFORMANCE

# IN SOFTWARE ENGINEERING

**Robert Lingard**
**Elizabeth Berry**
*California State University, Northridge*

## INTRODUCTION

Both educators and industry representatives seem to agree that to be successful in today's workplace, high levels of teamwork and communication skills are needed by engineering and computer science graduates (Lewis, 1998). In employer surveys, one of the most frequently mentioned skills lacking among CSU, Northridge computer science graduates was the ability to work effectively in teams. Many other universities have made similar observations and have begun efforts to improve the computer science curriculum in this regard.

At the University of Massachusetts, Dartmouth curriculum changes have been outlined which place a greater emphasis on the development of large software systems using student teams (University of Massachusetts, Dartmouth, 1999). At the University of Virginia the lack of an emphasis on team projects has been identified as a major deficiency in their computer science program (University of Virginia, 1999). Cal Poly, San Luis Obispo, the University of Texas, Austin and Georgia Tech have also specified teamwork and group projects as essential components of their computer science programs (Upchurch, 1994).

However, even when team projects are assigned in software engineering courses, students seldom receive any training on how to function collaboratively before such

assignments are given and little attention is given to how teams are formed. Consequently, teams often fail to function effectively.

According to a study at Brigham Young University, team process effectiveness was the major factor accounting for the success of group projects (Swan, 1994). Furthermore, students apparently do not learn much from participating on dysfunctional teams and often develop negative views about the value of teamwork (Aldridge, 1996).

Simply assigning more team projects is not sufficient in addressing the need for students to learn teamwork skills. In order for students to benefit from these team projects, efforts must be made to ensure that the teams are well formed and given the knowledge and tools necessary to operate effectively.

## DESCRIPTION OF THE STUDY

The main purpose of this effort was to develop techniques for improving team performance within group projects assigned to software engineering students. The first objective was to provide some specific instruction in group communication skills as part of the regular course of instruction, and the second was to improve the process of forming teams in order to maximize group effectiveness.

Last year, as a joint effort with the Communication Studies Department at CSU, Northridge, some specific instruction in group communication was given to two of the four sections of Computer Science 380, "Introduction to Software Engineering." The other sections received no such instruction. The instruction consisted of discussing the group process and how teams function. Students participated in an exercise that demonstrated the value of the group process, discussed group members' roles, analyzed their individual talents and those of their group, and assessed the group

process at various points in the semester. Students wrote about the problems they were having in completing their group projects and the instructors tried to help them solve those problems.

As for the second objective, groups were evaluated for group synergy using the Kolbe Conative Index (KCI-A®). According to Kolbe (1990), group synergy contributes positively toward group productivity. If true this would suggest that forming groups to maximize synergy would result in groups that worked together more effectively and would, therefore, provide students with a more beneficial group experience.

The KCI-A® is an instrument that measures *conation* or a person's inherent talent or natural way of doing things and predicts what a person will or will not do, given the freedom to act. Whereas intelligence tests measure I.Q. and personality tests measure values and preferences, the Kolbe index measures the conative, the way people act while trying to achieve goals. It identifies four modes or striving instincts--Fact Finder, Follow Thru, Quick Start, and Implementor -- each prompting people to act in a certain way. Synergy is a productive balance of instincts within a team. It is derived from a mixture of complementary, conative talents. Ideal synergy involves not only the right mix of instincts to initiate solutions, but the same amount of energy to avoid problems as well. It was this measure of group synergy that was used in this study.

## FINDINGS

A survey was given at the end of each semester to all four sections of the course asking students to assess their group experiences. In one of the questions, students were asked to rate the effectiveness of their team on a scale of 1 to

5, where 5 was "extremely effective" and 1 was "extremely ineffective."

Table 1 shows the average response for each team along with the average score on the group projects. The teams F-A through F-F and S-A through S-E were those that received specific group communication instruction, and the teams F-1 through F-5 and S-1 though S-7 were those that received none. The results show a significant correlation between the teams' ratings of their effectiveness and the scores on the projects [$r(21) = 0.451$, $p < 0.025$].

**Table 1. Team Results**

| Team ID | Project Scores | Effectiveness Rating | Team Synergy | |
|---|---|---|---|---|
| F-1 | 81.00% | 3.67 | 80.00% | 81.01% |
| F-2 | 79.00% | 4.00 | 75.00% | 72.93% |
| F-3 | 66.00% | 2.33 | 60.00% | 76.06% |
| F-4 | 78.50% | 2.75 | 50.00% | 77.71% |
| F-5 | 90.50% | 4.50 | 87.00% | 81.77% |
| F-A | 80.00% | 4.50 | 100.00% | 81.66% |
| F-B | 81.50% | 3.00 | 60.00% | 77.77% |
| F-C | 95.50% | 4.00 | 80.00% | 85.25% |
| F-D | 73.50% | 3.33 | 90.00% | 76.80% |
| F-E | 90.00% | 3.00 | 83.00% | 78.19% |
| F-F | 90.50% | 4.00 | 37.00% | 88.07% |
| S-1 | 78.00% | 4.00 | 80.00% | 76.45% |
| S-2 | 88.00% | 4.25 | 50.00% | 88.19% |
| S-3 | 82.50% | 4.00 | 80.00% | 83.30% |
| S-4 | 79.50% | 3.60 | 40.00% | 79.20% |
| S-5 | 84.00% | 3.80 | 80.00% | 84.25% |
| S-6 | 72.50% | 3.50 | 42.00% | 79.63% |
| S-7 | 75.00% | 4.00 | 80.00% | 81.10% |
| S-A | 81.00% | 4.40 | 80.00% | 75.10% |
| S-B | 80.50% | 2.33 | 80.00% | 74.86% |
| S-C | 73.50% | 3.50 | 75.00% | 77.94% |
| S-D | 85.50% | 4.40 | 90.00% | 78.55% |
| S-E | 86.50% | 4.20 | 80.00% | 78.85% |

One of the main objectives of this study was to examine team composition as a factor in determining team effectiveness. The fourth column in the table below shows the measure of team synergy based on the "conative" assessments of all team members using the Kolbe Conative Index. Each team member was assessed using this instrument and from that information a measure of group synergy was determined for each team. The synergy is expressed as a percentage where 100% indicates ideal synergy. One hypotheses of this experiment was that higher synergy would result in higher team scores. At first examination the data suggest no such correlation.

There was, however, a very significant correlation between Project Scores and the combined test scores of the team members. Column five of Table 1 shows the average test scores from the mid-term and final exams for the members of each team. This correlation is significant at the 0.005 level [$r(21) = 0.564$, $p < 0.005$].

This result is hardly surprising. It suggests that teams made up of students who do well on tests do well on group projects. However, this correlation is so high that it might be obscuring any effect of synergy on group achievement. If the population of teams is considered without exceptional high or low test scores, in particular, only those teams within two standard deviations of the mean, there is a significant correlation between group synergy and project scores [$r(19) = 0.380$, $p < 0.05$]. With these more cognitively balanced teams there is also a high correlation between each team's rating of its own effectiveness and team synergy [$r(19) = 0.478$, $p < 0.025$]. Further study using cognitively balanced teams is necessary to validate this result.

In addition to studying group formation as a means to improve team performance, efforts were made to provide specific instruction in group communication as part of the regular software engineering curriculum. Another hypothesis

of the experiment was that the classes receiving this instruction would do better on group projects and rate their group experiences more positively. Although the data, as summarized in Table 2, show higher project scores for the classes receiving the instruction, the difference is not statistically significant for this relatively small sample. The results are encouraging, but more study is needed to accurately determine the effect of such instruction on group performance.

**Table 2. Effect of Group Communication Instruction**

| Class | Project Scores | Effectiveness | Team Synergy | Test Scores |
|---|---|---|---|---|
| F98 - No Instr. | 79.00% | 3.45 | 70.40% | 77.90% |
| F98 - w/Instr. | 85.17% | 3.64 | 75.00% | 81.29% |
| S99 - No Instr. | 79.93% | 3.88 | 64.57% | 81.73% |
| S99 - w/Instr. | 81.40% | 3.77 | 81.00% | 77.06% |
| Total - No Instr. | 79.68% | 3.67 | 65.82% | 80.47% |
| Total - w.Instr. | 83.45% | 3.70 | 77.73% | 79.37% |

## CONCLUSIONS AND RECOMMENDATIONS

The results of this experiment support the notion that there is a direct relationship between group effectiveness and project success. The results also suggest that group project achievement can be improved by taking more care in the way teams are formed. High team synergy appeared to contribute to group achievement. While the results of this initial experiment are encouraging with respect to providing instruction in group communication, further work is needed to establish whether this correlates significantly with group performance.

The experiment clearly showed a strong relationship between achievement on tests by team members and group

project success. This suggests that to be fair in forming groups, the groups should be balanced with respect to knowledge of software engineering. This would help to ensure that all teams would have an equal chance to do well and would improve the likelihood that all students could participate in a successful team experience.

The results of this experimental effort strongly suggest that more attention should be given to the process of forming groups. Rather than forming groups in some arbitrary fashion or just allowing students to form their own groups, groups should be formed carefully, taking into account both the cognitive skills and the conative talents of the individual group members. In this way the best possible group performance can be assured which will provide students with the greatest opportunity to learn software engineering.

## REFERENCES

Aldridge, M. D., et al. (1996). *Introduction to team-based design for students in engineering, business, and industrial design* (Final report to the National Science Foundation, Grant # DUE-9354523). Auburn, AL: Auburn University.

Kolbe, K. (1990). *The conative connection*. Reading, MA: Addison Wesley.

Lewis, P., et. al. (1998). Assessing teaming skills acquisition on undergraduate project teams. *Journal of Engineering Education, 87(2)*, 149-155.

Swan, B. R., et. al. (1994). A preliminary analysis of factors affecting engineering design team performance. *Proceedings, 1994 American Society for Engineering Education Annual Conference* (pp. 2572-2589). Edmonton, Canada: American Society for Engineering Education

University of Massachusetts, Dartmouth. (1999). *Putting software process in computer science education* (National Science Foundation, Award No. DUE-9555042). [On-line]. Available: http://www2.umassd.edu/SWPI/nsfccd/nsfccd.html

University of Virginia (1999). *Curriculum*. [On-line]. Available: http://www.cs.virginia.edu/curriculum/

Upchurch, R. (1996). *Software process education*. [On-line]. Available: http://www2.umassd.edu/SWPI/1docs/SPEd.html

# INNOVATIVE STRATEGIES

# FOR TEACHING AND LEARNING

# AT A DISTANCE

**Pam Northrup**
*University of West Florida*

## INTRODUCTION

*Students from around the globe log onto the class Web site and enter the chat room to begin collaborating with their study partners. In the chat room, the instructor provides guidance and mentoring as the team of students shares ideas and propose strategies for the investigation of archaeological artifacts from a sunken 16th century ship located at the bottom of the Pensacola Bay.*

*Using live video streaming, students discuss with underwater archaeologists a specific issue of identifying the bow of the sunken ship in murky waters. Based on input from archaeologists, the student team reaches a decision about how to proceed. They move into the investigation section of the Web site to begin identifying and classifying the artifacts located during the previous day's dive.*

These students are participating in an Online Internet Expedition, *The Search for Luna* (Rasmussen, 1998), learning scientific investigation techniques in an authentic environment. By using the context of an archaeological field school, learning takes place that is meaningful to students as they are actively engaged. Brown and Palincsar (1989) note that when the content of a lesson is embedded within the task itself, the

learner can interpret relationships and make connections in complex, ill-structured tasks. In addition to providing a student venue for learning, these expeditions offer preservice and inservice teachers the opportunity for professional development through modeling new curriculum strategies that integrate technology into the learning environment. These activities, in conjunction with other strategies, offer a series of comprehensive strategies that promote effective teaching and learning in distance learning environments.

## A Theoretical Foundation: Designing Engaging Learning at a Distance

Distance learning is defined broadly as teaching when instructor and student are separated by time or distance. This separation can be disadvantageous unless thoughtful, systematic planning is done relevant to how the learning environment will be structured to ensure success. There are many different strategies that can be employed to build collaborative, interactive learning environments. Using the *Grounded Design* framework proposed by Hannafin, Hannafin, Land, & Oliver (1997), a foundation for distance learning experiences was established to meet learner needs and curricular requirements (see Table 1).

**Table 1: Theoretical Framework for Distance Learning***

| Framework | Theoretical Basis |
|---|---|
| Psychological | Situated Cognition (Brown, Collins & Duguid, 1989; Brown & Palincsar, 1989) |
| Pedagogical | Anchored Instruction (Cognition & Technology Group, 1992; Linn 1995; Vygotsky, 1978) |
| Technological | Utility on the Web (Khan, 1997; Starr, 1997) |
| Cultural | Learning Organizations, Social Learning, and Individual Differences (Bandura, 1969; Kolb, 1984; Senge, 1990) |
| Pragmatic | Administration, Student Interpretations, and Motivation (Berge, 1997; Knowles, Holton & Swanson, 1998; Wiggins, 1995; Wlodowski, 1993) |

* Taken from Northrup & Rasmussen (2000).

According to Hannafin, et. al (1997), Grounded Design is the systematic implementation of processes and procedures that are rooted in established theory and research in human learning. Based on this model, *design variables that are recommendedfor inclusion within distance learning courses include apprenticeships, modeling, scaffolding, coaching/mentoring, collaboration, authentic context, authentic activity, and reflection.*

## ESTABLISHING A DESIGN

### Types of Designs

Based on a review of distance courses, courses appear typically to consist of one of three approaches--Open-ended, Traditional or Authentic. A discussion of these three types follows.

***Open-ended.*** The Open-ended approach may provide students with little guidance, but, rather, permits negotiation on the major assignments. In this approach, students receive

little or no directive from the instructor and are left to determine requirements on their own.

***Traditional***. The Traditional approach takes lecture-based materials and places them on the Web. In this scenario, students may view an instructor's PowerPoint presentations, see lecture notes and email the instructor for guidance and support. However, this approach doesn't take advantage of the medium of distance delivery and may be better taught in a traditional class (unless students are truly physically separated by distance).

***Authentic.*** The third strategy is to engage in authentic activity with the student while continuing to maintain a clear direction about assignments. This approach requires a great deal of interaction with the student in the form of guidance and mentoring.

**Types of Interaction**

Regardless of the strategy used for the overall design of the course, designing an interactive environment is an essential element for course success. Rasmussen & Northrup (1999) propose that interaction should include-- student-to-student, student-to-instructor, student-to-content and student-to-management--for the course to be successful.

***Student-to-Student Interaction.*** This can be designed by establishing peer groups to review each others' work, establishing cooperative learning groups and setting weekly times for students to discuss with other students specific course content, possibly in a Student Café or Chat Room.

***Student-To-Instructor Interaction***. This type of interaction must occur on a routine basis. Some common strategies to promote student-to-instructor interaction may include setting weekly office hours online, using e-mail, or going into a private chat room. Included also should be time with instructors presenting key concepts, using Real Presenter

to conduct a PowerPoint presentation, streaming video presentations, sending out (and responding to) e-mail to individual students and to group listservs, or meeting via interactive whiteboard programs like NetMeeting.

***Student-To-Instruction Interaction.*** This is usually the most common form of interaction. If the content is engaging and meaningful, this interaction can be an extremely valuable component of the course. If students are simply reading text from a Web page, it is unlikely that it will be a motivating, meaningful experience.

***Student-To-Management Interaction***. This is an unusual form of interaction. However, knowing exactly what assignments have been received, what grades have been attained, and what is still expected is critical for student success and satisfaction. Students and instructors make the mistake of trying to have every single event on the Web as a graded assignment. In a traditional class, instructors don't usually try to grade group discussion, but do grade assignments that are turned in such as papers, presentations, and projects. A management system that keeps track of assignments completed and provides a vehicle for e-mailing is a valuable resource toward overall course interaction. Programs such as WebCT and Blackboard facilitate monitoring student progress.

## INSTRUCTIONAL STRATEGIES FOR DISTANCE TEACHING AND LEARNING

There are several strategies that can be used when designing and developing the interactive content of the course. These examples have been very successful at the University of West Florida.

***Online Expeditions***. *The Search for Luna* was a four-week investigation of a 16th century sunken Spanish ship located in Pensacola Bay. Using streaming technology, experts

interacted with students and took them to the bottom of the murky waters where the ship was discovered.

***Electronic Performance Support Systems (EPSS).*** Courses are also designed around the Electronic Performance Support Systems notion that provides support for human performance. An EPSS provides integrated, on-demand access to information, advice, learning experiences and tools to enable a high level of job performance with a minimum of support from other people (Gery, 1991; Raybould, 1995). EPSS should focus on developing everyday performance of its users.

STEPS (Northrup & Pilcher, 2000) is a tool that was designed for preservice and inservice teachers to assist with lesson planning that adheres to Florida's School Reform and Accountability initiatives. Imbedded scaffolding assists the user in making appropriate decisions for lesson planning. STEPS is designed around four components (information, advice, learning experiences and tools), providing students with a complete instructional package. In addition, STEPS has over 50 instructional tutorials embedded within The Lesson Architect$_{TM}$ databases full of best practices and Web links to provide ideas and resources.

In a graduate Instructional Design course, a Web-based Electronic Performance Support System called ID Town was designed as the primary tool for students to learn to design and develop instruction using systematic principles of instructional design. ID Town uses a Design Document as its centerpiece and contains guidance and support (e.g., practice worksheets, reference to the Instructional Design text, instructional tutorials and a database full of strategies and ideas for putting creativity into the instructional design process).

*Case Studies.* A third strategy for interactive, engaging Web-based instruction is using Case Studies. At San Diego State University, a case study entitled Aztechnology Turns is

situated as a soap opera where performance technology students interact to discover how to work with subject matter experts and clients in building an Electronic Performance Support System. At the Curry School of Education, a series of national Instructional Design Case Competitions for graduate students in instructional design programs were developed. Utilizing real resources, documentation, and records, students work within the case to propose probable solutions to real problems. In a multimedia course at the University of West Florida, a case study entitled, "Who Shot KR?" was developed dealing with issues surrounding multimedia design teams, emphasizing teamwork and collaboration.

## ESTABLISHING THE SOCIAL CONTEXT OF THE COURSE

In dynamic, interactive distance learning environments, the social context of the course must be developed early in the semester. Students who are comfortable in this new environment, even though they are separated by time and distance from the instructor, will thrive. Students not comfortable will feel separation and in many instances, will drop the course. To establish the social context, consider the following strategies:

*Course Orientation*. Provide a course orientation that denotes clearly the role of the student in a distance course. The orientation should include what it takes to be a distance learner in the course. Directions for weekly assignment and activities along with responsibilities of all involved in the course must be clearly articulated to students.

*Time Management and Organization*. Provide heuristics for time management and organization for distant students by providing structure for guiding students on a weekly basis. Directions, course assignment sheets and daily

interaction with students appear to have the most positive effect. Most students will openly admit that they have little ability to manage or organize their time to be a successful distance student. To provide a framework that still allows for learning flexibility, both synchronous and asynchronous activities are recommended to occur each week.

***Getting Acquainted Activities***. Conduct activities that allow students to get to know each other during the "first class period." Any icebreaker that allows students to learn a bit about each other will work. This type of activity promotes high levels of engagement and provides students a "no-risk" time to practice using course technologies.

## CONCLUSIONS

Designing a highly engaging, interactive learning environment is essential to ensure student success in a distance learning environment. Promoting interactivity facilitates overall student involvement in the course and provides a construct for the design of activities and learning experiences. Providing that the social context of the course is established ensures that students develop a comfort level for success and satisfaction.

## REFERENCES

Brown, J. S., & Palincsar, A. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*(1), 32-42.

Gery, G. (1991). *Electronic performance support systems.* Boston, MA: Weingarten.

Hannafin, M. J., Hannafin, K. M., Land, S. M., & Oliver, K. (1997). Grounded practice and the design of constructivist learning environments. *Educational Technology Research and Development, 44*(3), 1997.

Northrup, P. T., & Pilcher, J. A. (2000). *STEPS*. [On-line]. Available: http://www.steps.uwf.edu.

Northrup, P. T., & Rasmussen, K .L. (2000, February). *Designing a Web-based program: Theory to design.* Paper presented at the annual conference of the Association for Educational Communications and Technology, Long Beach, CA .

Rasmussen, K. L. (1998). *The search for Luna*. [On-line]. Available: http://mentor.coe.uwf.edu/delunaexpedition.

Rasmussen, K. L., & Northrup, P. T. (1999). *Strategies that facilitate instructor-student communication*. Paper presented at Ed-Media 99, Seattle, WA.

Raybould, B. (1995). Performance support engineering: An emerging development methodology for enabling organizational learning. *Innovations in Education and Training International, 32*(1), 65-69.

# ANALYTICS: AN INTEGRATED MATHEMATICS, LOGIC AND PHILOSOPHY OF SCIENCE COURSE

**Michael R. Pinter**
*Belmont University*

## INTRODUCTION

The Analytics course at Belmont University is an interdisciplinary course in the Honors program curriculum. The course integrates mathematics, logic, computer science and some philosophy of science, with problem-solving as an overall theme. The course includes laboratory exercises, small group work and extensive reading and writing. Experiences and readings are designed to illustrate some of the methods used and questions asked by members of scientific and mathematical disciplines. *One of the primary goals of the course is that students learn to search for connections between various topics, in several disciplines, as they study how others search for truth.*

The course instructors include faculty members from mathematics, philosophy and computer science. They have identified several goals that frame the Analytics course. One goal is for students to develop a sense of the nature of what scientists and mathematicians do; in particular, the class discusses problem-solving from scientific, logical, and mathematical perspectives. Along with problem-solving, the course topics engender the sense that science and mathematics is a bit more "slippery" than the students first believe. In this regard, the development of the bodies of knowledge called science and mathematics is similar to the development and growth of knowledge in general.

To introduce students to the dynamic nature of science and mathematics, the course deals especially with aspects of mathematics that show it to be alive and changing. While some formulas are developed along the way, the emphasis is almost entirely on the process of obtaining the formulas rather than on the formulas themselves. Students are exposed to a notion put forth by Devlin (1997, August) that mathematics helps to make visible ideas and concepts that were previously invisible to them. For instance, an exercise designed to help students discover a pattern in number sequences logically leads to the formula for compounded interest.

An additional goal in the course is that students develop an appreciation for the human endeavor aspect of science and mathematics. In so doing, the students better understand why some individuals choose to study mathematics or science and the passion that can be involved. To aid in this understanding, the students read materials such as those by Hoffman (1987, November), Sacks (1985) and Trudeau (1993). They also view some videos that include artistic, creative and emotional elements in the pursuit of mathematics.

## SOME COURSE SPECIFICS

The general flow of topics in the course follows. The course begins with two to three weeks on problem-solving from a philosophical/logical perspective, including the metaphor of a scientist as detective. To enhance this metaphor, students usually view a movie with a "detective" theme. The latter part of this unit is a discussion based in the philosophy of science, using Kuhn's (1970) writing as the primary text.

The course then briefly explores the development of mathematical logic. The students learn how to use truth tables to study the validity of logical arguments. The students are also directed to a rich source of examples that were developed

by Charles Dodgson (writing under the name Lewis Carroll) and made available on the World Wide Web by Dean (1998). In addition, they see connections to Boolean algebra, which serves as a precursor to circuit design. A brief discussion of Gödel's Theorem (which concerns the inevitability of paradox in any system of logic because of problems that arise when self-referencing) helps to connect the mathematical logic to ideas from the philosophy of science.

After completing the unit on mathematical logic, the course turns specifically to mathematical problem-solving approaches. The goal at this point is for students to discover patterns and structure in different areas of mathematics. Counting problems and number patterns are used initially to address this goal, followed by the study of graph theory. In graph theory, the emphasis is on "relationship" rather than number, size or quantity. Nearly all of the material in this portion of the course is selected in order to engage students with discovery-based learning in a mathematical setting.

Within the larger problem-solving discussion, students move from attacking problems by "brute force" to solving them with inductive and deductive reasoning. As part of this, the students notice that there are qualitative differences in ways of solving problems. In particular, a distinction is made between a "cassette tape" approach (linear in nature) and a "compact disc" approach (allows for random access).

In order for students to experience the nature of open-ended problem solving in a mathematical framework, a problem-solving group project is incorporated into the course at this point. Students select a single problem from a variety of offered problems; they have no specific context for the problem to serve as a "clue" for how they should approach a solution. Thus they are forced to put into practice the notions of problem-solving they've just learned, wherein they "start small" and discover how to proceed through the problem as

they go. Each group of students is expected to orally present their solution to the rest of the class.

Within the context of problem-solving, the students are exposed to a wide variety of problems. Some of the problems are specifically chosen to demonstrate that two problems can be virtually identical in statement yet very different in their solutions. In particular, students see pairs of almost identical problems with one problem having quite an easy solution and the other in the pair having a solution that's very difficult to obtain.

After these developments, the class briefly studies dynamical systems, chaos and fractals; the primary model used is the logistic growth equation for studying population dynamics, which also provides an interesting contrast with the commonly used exponential growth model. In this context, a spreadsheet is used as a mathematical tool to help students explore and discover some features of mathematical chaos. In particular, the students see another demonstration of problems that can arise when a model has a self-referencing element.

The ideas of logic and problem-solving are then further developed to discuss the logical nature of circuits and computers. Students engage in developing circuits as a lab exercise. The course uses computer science to introduce the primary topic of this unit, artificial intelligence. As the class explores current applications of artificial intelligence, they also discuss some of the advantages, disadvantages, and limitations of artificial intelligence.

The course ends with a weeklong discussion of the book *Jurassic Park* (Crichton, 1990). Many ideas encountered during the course reappear in these discussions, including philosophy of science issues, mathematical chaos, counting and computing. The ethical issues of *Jurassic Park*, including whether science should do everything it is capable of, and the question of responsibility for scientific products, are also addressed.

Several years ago the course instructors were preparing to use a text other than *Jurassic Park* for the ending discussion. However, actual cloning became front-page news and the book seemed all the more relevant. Nearly every year many of the students cite the *Jurassic Park* discussion as a very good way to end the course.

## COURSE WRITING COMPONENTS

A strong reading and writing component helps students connect their own suppositions to those they encounter in the course. In addition to the primary course texts, the individual instructors provide many supplemental readings. Students also write response essays and reflective journal entries to a number of related readings scattered throughout the term, such as the articles by Hoffman (1987, November), Hofstadter (1984), Knuth (1984), Schilling (1991, January), Wiener (1984) and Horgan (1993). These readings are generally timed to tie in with class discussions.

In order to facilitate connections both within this course and between this course and other courses, students are required to keep a journal throughout the course. The journal is also an avenue for students to deal with open-ended questions that are presented in class and in the readings. In addition, course examinations typically include questions that require well-developed written responses.

Students are required to develop a course portfolio that reflects their course experience. Ideas for the format and intent of the portfolio come from Murnane (1993). Among other items, the portfolio includes the following: a collection of exercises and problems worked on during the course; items from the popular media that have a mathematical/scientific connection; and a mathematics/science autobiography journal entry from the beginning of the course along with a final journal entry that is a reflection on the autobiography.

To encourage reflective thinking by the students, the portfolio also includes responses to each of the following prompts:

> *What single item in your portfolio most effectively demonstrates an accomplishment for you in this course?*
>
> *Name one thing about the course that was helpful to you.*
>
> *Has your perception of mathematics and or science changed as a result of this course?*

## OBSERVATIONS AND CONCLUSIONS

By the conclusion of the course, students have had opportunities to explore and form their own philosophies about the nature and role of science and mathematics in the modern world. They have also developed some skills in logic and problem-solving. Perhaps the most valuable gain for students is insight into the dynamic aspects of mathematics and science and the ability to see what was previously invisible to them. Students have generally enjoyed the attempt to integrate knowledge from what they previously perceived as diverse areas.

The course has been well received thus far by the students. Reading and writing aspects of the course have been considered one of the strongest points of the course. The course portfolios usually offer a strong presentation of each student's insights and reflections. In that regard, the students seem to be more aware of how and why they learn (at least related to mathematics and science).

## REFERENCES

Crichton, M. (1990). *Jurassic park*. New York: Ballantine Books.

Dean, C. (1998). *The Lewis Carroll e-text collection*. [Online]. Available: http://home.earthlink.net/~lfdean/carroll

Devlin, K. (1997, August). Making the invisible visible. *FOCUS: the newsletter of the Mathematical Association of America*, 2-3.

Hoffman, P. (1987, November). The man who loves only numbers. *The Atlantic Monthly*, 60-74.

Hofstadter, D. (1984). Analogies and metaphors to explain Gödel's theorem. In D. Campbell & J. Higgins (Eds.), *Mathematics: People, problems, results. Vol. II* (pp. 262-275). Belmont, CA: Wadsworth.

Horgan, J. (1993, October). The death of proof. *Scientific American*, 92-103.

Knuth, D. (1984). Mathematics and computer science: Coping with finiteness. In D. Campbell and J. Higgins (Eds.), *Mathematics: People, problems, results. Vol. II* (pp. 209-222). Belmont, CA: Wadsworth.

Kuhn, T. (1970). *The structure of scientific revolutions* (2nd ed.). Chicago: University of Chicago Press.

Murnane, Y. (1993). Good grading: Student portfolios--a primer. *The National Teaching and Learning Forum, 3*(2), 1-4.

Sacks, O. (1985). Twins. In *The man who mistook his wife for a hat and other clinical tales* (pp. 195-213). New York: Summit Books.

Schilling, S. P. (1991, January). Chance and order in theology. *Theology Today*, 365-376.

Trudeau, R. (1993). Pure mathematics. In *Introduction to graph theory* (pp. 1-11). New York: Dover Publications.

Wiener, N. (1984). Some moral and technical consequences of automation. In D. Campbell and J. Higgins (Eds.), *Mathematics: People, problems, results. Vol. III* (pp. 59-68). Belmont, CA: Wadsworth.

# ANDES: A COACHED LEARNING ENVIRONMENT FOR CLASSICAL NEWTONIAN PHYSICS

**K. G. Schulze**
**R. N. Shelby**
**D. J. Treacy**
**M. C. Wintersgill**
*United States Naval Academy*

## INTRODUCTION

Andes is an intelligent tutor for classical Newtonian physics that is being developed by a team of researchers at the Learning Research and Development Center at the University of Pittsburgh and researchersat the United States Naval Academy. This paper describes the Andes system.

Physics homework has traditionally been very time consuming and frustrating for students. Unsupported homework may even be a source of many of the incorrect algebraic, symbol-pushing habits that are so widespread and harmful (Halloun & Hestenes, 1985; Larkin, 1983). Consequently, one of the early goals of Andes was to provide a robust environment that would help a student solve homework problems without the aid of a human teacher. In addition to possibly reducing the negative effects just cited, it was also felt the use of Andes would provide more classroom time for demonstrations and coverage of conceptual issues.

The Naval Academy is an excellent test bed for the system because all students are required to take two semesters of calculus-based physics in their sophomore year.

Approximately 36% of these students are engineering majors, 25% are math and science majors, and 39% are humanities and social science majors. As a result, the researchers were able to determine the effect of Andes across a spectrum of students. Andes has been used by midshipmen in a few sections of Physics I since the fall of 1997. There were approximately 173 students using Andes during the fall semester of 1999 with another 162 students acting as a control group.

## PEDAGOGY

Three of the researchers at the Naval Academy are physics professors, so the system has striven to embed the same pedagogical philosophy that is used in the classroom. For example, students are encouraged to draw free body diagrams when appropriate, label the vectors, and solve problems using components. Studies have shown that immediate feedback improves learning (Anderson, et al., 1995; Kulik & Kulik, 1988), so Andes provides immediate feedback by incorporating the color green to indicate correct student actions and red to indicate incorrect ones. If a student receives red feedback, s/he may immediately ask Andes "What is wrong with that?" and receive a hint.

Students are encouraged to define the symbolic variable names first, then to use them to enter symbolic equations and finally to solve for the numerical answer. In order to provide the student with an incentive to use the system and to stop poor algebraic skills from undermining the conceptual issues the student is trying to learn, Andes allows the student to select an equation, and click on a *solve button* which will then perform the algebraic/arithmetic manipulations necessary to simplify the equation.

The current system is able to solve vector, static forces, translational and rotational kinematics, translational

and circular rotation dynamics, energy, angular momentum, and torque problems. It is anticipated that friction, work and linear momentum problems will be added to the system by the fall of 2000.

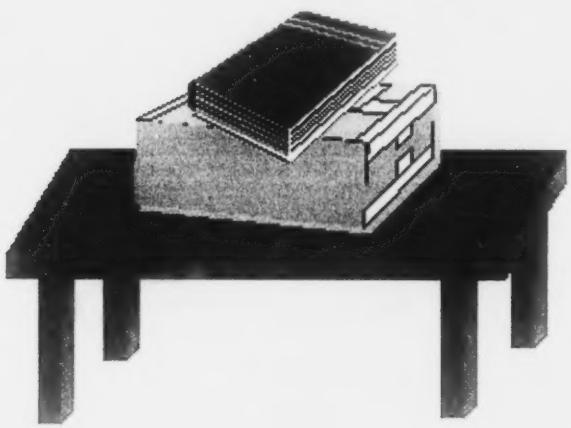
Andes is flexible enough to provide multiple solutions to a problem if they exist (Schulze, et al., 1998). For example, the problem illustrated in Fig. 1 can be solved either by using two separate bodies or by using a compound body, and Andes allows the student to solve it either way.

**Fig. 1: An Andes Problem**
**With Two Possible Solution Paths.**

**A package of mass 6.00 kg rests on a table. A book of mass 2.00 kg rests on the package.**

**What is the magnitude of the normal force exerted on the package by the table?**

Answer:



The problem illustrated in Fig. 2 can be solved with the x-axis horizontal or along the direction of the acceleration. The

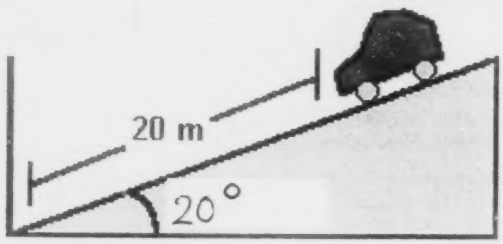
student can select either of these axes to construct the free body diagram and solve the problem.

**Fig. 2: An Andes Problem With Two Potential Axes.**

**A 2000-kg car in neutral at the top of a 20-degree inclined driveway 20 m long slips its parking brake and rolls down. Assume that the driveway is frictionless.**

**At what speed will it hit the garage door?**

**Answer:**




Although the system has been developed in CLIPS, Lisp, and C++, it is an application the student downloads onto his PC from the web. This allows for easy implementation of upgrades throughout the semester and because the system resides on dedicated machines, very rapid feedback is possible. Andes currently runs under Windows 98 and Windows NT.

## ARCHITECTURE

Andes consists of an authoring environment, developed by researchers at the Naval Academy, and a student environment, developed by the researchers at the Learning Research and Development Center. The student environment contains five major modules: 1) the action interpreter; 2) the assessor; 3) the interface; 4) the help system; and 5) the student model.

BEST COPY AVAILABLE

## AUTHORING ENVIRONMENT

The authoring environment consists of the given conditions of a problem and a physics problem solver or knowledge base. This knowledge base contains approximately 500 rules comprised of two types: planning rules and physics knowledge rules. The pedagogical philosophy embedded in the knowledge base is described by Schulze

(Schulze, et al., 1998). An example of each type of rule can be seen in Fig. 3.

**Fig. 3: (A) A Planning Rule**
**And (B) A Physics Knowledge Rule**

(A) If
the subgoal is to use Newton's Laws and
a body exists
then
create a subgoal to find the mass of the body.

(B) If
the subgoal is to find the vector properties of the acceleration vector
a net force vector exists at the same time as the acceleration vector
the direction of the net force vector is known
then
the direction of the acceleration vector is the same as the direction of the net force vector

The given conditions of a problem are used as input to the knowledge base. As a matter of policy, the input matches the written problem statement as closely as possible with a minimum of interpretation. Outputs from the knowledge base consist of all the equations necessary to solve the problem and

a graph indicating the solution path. These equations and the solution graph are then used by the action interpreter and assessor modules to provide appropriate hints.

## ACTION INTERPRETER AND ASSESSOR

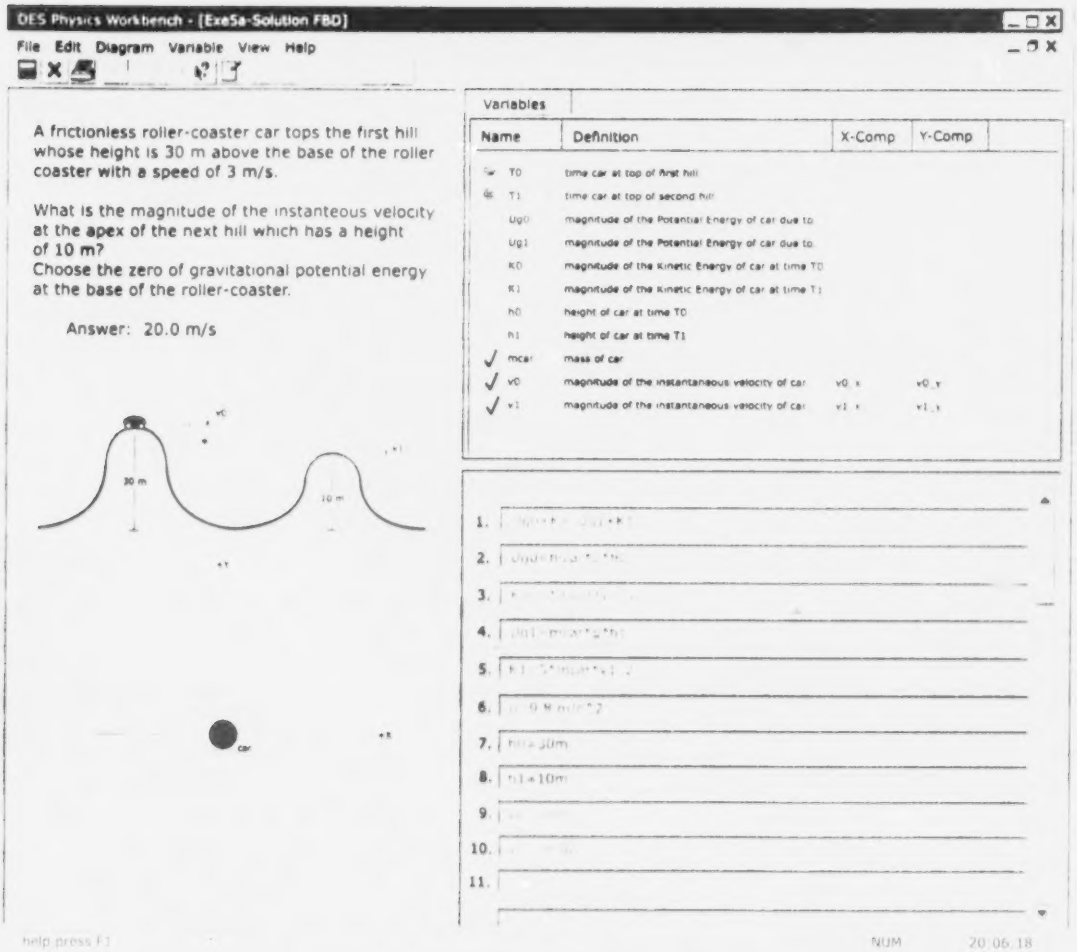
The action interpreter module interprets the student's problem solving action in the context of the current problem and determines the type of feedback to provide. For example, if the student enters an equation, it is compared to the set of equations produced by the knowledge base and if a match occurs, the equation turns green. If there is no match, it turns red.

If the student asks for help on a red object, the assessor determines where in the solution graph the correct object resides and passes this information to the Help system. The assessor module updates the Bayesian network in the student model.

## INTERFACE

The interface, referred to as the Andes Workbench, provides an interactive environment in which the student works the physics problem. It consists of several panes and multiple tools as indicated in Fig. 4.

**Figure 4. The Interactive Interface For Andes**


DES Physics Workbench - [ExeSa-Solution FBD]
File Edit Diagram Variable View Help
A frictionless roller-coaster car tops the first hill whose height is 30 m above the base of the roller coaster with a speed of 3 m/s.
What is the magnitude of the instanteous velocity at the apex of the next hill which has a height of 10 m?
Choose the zero of gravitational potential energy at the base of the roller-coaster.
Answer: 20.0 m/s
30 m
10 m
car
Variables
Name
Definition
X-Comp
Y-Comp
T0 time car at top of first hill
T1 time car at top of second hill
Ug0 magnitude of the Potential Energy of car due to
Ug1 magnitude of the Potential Energy of car due to
K0 magnitude of the Kinetic Energy of car at time T0
K1 magnitude of the Kinetic Energy of car at time T1
h0 height of car at time T0
h1 height of car at time T1
mcar mass of car
v0 magnitude of the instantaneous velocity of car
v1 magnitude of the instantaneous velocity of car
help press F1
NUM
20:06:18

**Toolbars**. The toolbar across the top contains the normal buttons to open, close, print, cut and paste. In addition, it has a *help* button that strictly provides help with using the interface, a *help* button that can be selected to receive help on why an object has been turned red, and a generic *hint* button that the student can select when he has no idea what to do next. There is a *solve* button that will solve an equation for a specified variable, a *comment* button the student can use to

BEST COPY AVAILABLE

provide annotated comments, a *calculator* button and a *Greek keyboard* button that will allow the student to type Greek characters.

The toolbar running down the left side of the interface contains buttons to aid in drawing vector quantities. There are buttons that allow the student to construct a body, an axis, a force vector, an acceleration vector, etc. Any buttons that are irrelevant to the specific problem are disabled.

**Three Panes.** The interface is divided into three panes. The leftmost pane contains a statement of the problem along with a pictorial representation. The student can use the empty space in this pane to construct a free body diagram and draw any vector quantities which may aid in her/his visualization of the problem.

As the student constructs the diagram, s/he is required to assign variable names. For example, when s/he selects the body tool and clicks in the pane, a dialog box appears that requires her/him to identify the body and to name it. The variable name s/he selects then appears in the upper right Variable Window. If s/he correctly chose the body, the body will turn green in the left pane and the variable name in the Variable Window will receive green check mark as well as provide an English notation as to what the variable represents.

When s/he constructs a vector, such as *Fw* for the weight vector, the Variable Window will contain the variable *Fw* representing the magnitude of the vector, and if s/he has chosen an axis, the variables *Fw_x* and *Fw_y* representing the components of the vector. The bottom right window acts as a sheet of lined paper on which s/he can enter equations. When s/he has solved the problem, s/he enters her/his answer in the Answer box in the left pane.

## HELP SYSTEM

There are several help components in the system (Gertner, et al., 1998). The first is a simple help system for the interface itself. The student can also choose to run a video demonstrating how to interact with the Andes Workbench. The other two components of the help system are tied to the solution graph in the action interpreter and assessor modules. One component of the Help system supplies help that is connected to the immediate feedback supplied to the student and Andes scaffolds the hints in order to provide the student with the least amount of help necessary. For example, if the student draws the weight vector vertically upward, the Help module will pop up a window below the diagram containing the hint "Think about the direction of Fw." The student can then select an *explain further* option and receive the hint "Remember that gravity exerts a force straight down." S/he can then ask for a further explanation, at which point Andes will state that "The direction of Fw is straight down." The student can then select a *why* option and receive the explanation that "The direction of the gravitational force on an object is straight down toward the center of the planet."

Anytime during the above help process, the student can also select the *hide* option and the hints will disappear. If a hint has an underlined word in it, such as force in this example, s/he can click on the word and a definition will pop up. In this case, clicking on force will produce "The agent of change of motion of an object."

The other help component provides hints to the student when s/he has reached an impasse and has no idea how to proceed. For example, if s/he has correctly constructed a body named "b" and drawn the weight vector, named "Fw", then the Variable Window will contain the variable "mb" representing the mass of the body and "Fw" representing the magnitude of the weight vector. If the student has no idea

what should be done at this point, s/he can select the *light bulb* button in the top toolbar and receive the hint "Write an equation relating 'g', 'Fw' and 'mb'. S/he can again select the *explain further* option and receive the hint "Write the equation Fw = g * mb." If s/he selects the *why* option, s/he will receive the explanation "The magnitude of the weight of the body near a planet is equal to the mass of the body times the gravitational acceleration of that body." Again, s/he can always select the *hide* option when the hints are no longer needed.

## STUDENT MODEL

The student model is maintained via a Bayesian net and is updated at the end of each problem (Conati, et al., 1997; VanLehn, et al., 1998). If the Bayesian net determines the student does not understand a concept, such as the normal force, a short mini lesson explaining the concept will appear on the screen. Future work with the Bayesian net will hopefully provide the student with hints that are more tailored to his specific knowledge.

## CONCLUSIONS

Andes has been successfully used with a limited number of students at the Naval Academy for three years. Preliminary results of a study involving 173 students using Andes and 162 students acting as a control group indicate that Andes significantly improves the performance of students who were in the lower half of the class on a physics diagnostic exam.

Andes is still not robust enough for release to the educational community. The researchers are currently working on adding friction, work and linear momentum problems to the system. At that point, the majority of the topics covered in a

first semester physics course will be covered by Andes and it is anticipated to be released for use by others.

In addition to a larger problem set, the researchers are also considering requiring the student to provide better solution clarity by requiring her/him to draw a free body diagram when appropriate, to enter symbolic equations and to delay using numerical values until the last step in the solution, etc.

In addition, more work refining the hints provided to the students needs to be done. Future work will include a Principles Window in which the student will need to indicate which physics principles are necessary to solve the problem. As the student progresses through the problem and completes a principle, s/he will receive feedback that s/he has successfully applied the principle.

## REFERENCES

Anderson, J. R., Corbett, A. T., Koedinger, K. R., & Pelletier, R. (1995). Cognitive tutors: Lessons learned. *The Journal of the Learning Sciences*, 4(2), 167-207.

Conati, C., Gertner A., VanLehn, K., & Druzdzel, M. (1997). On-line student modeling for coached problem solving using Bayesian networks. In A. Jameson, C. Paris & C. Tasso (Eds.), User modeling. *Proceedings of the Sixth International Conference, UM97* (pp. 231-242). Vienna: Springer.

Gertner, A., Conati, C., & VanLehn, K. (1998). Procedural help in Andes: Generating hints using a Bayesian network student model. *Proceedings of the 15th National Conference on Artificial Intelligence* (pp. 106-111). Cambridge, MA: MIT Press.

Halloun, I. A., & Hestenes, D. (1985). Common sense concepts about motion. *American Journal of Physics*, 53(11), 1056-1065.

Kulik, J. A., & Kulik, C. L. C. (1988). Timing of feedback and verbal learning. *Review of Educational Research*, 58, 79-97.

Larkin, J. (1983). The role of problem representation in physics. In D. Gentner & A. Stevens (Eds.), *Mental models*. Hillsdale, NJ: Lawrence Erlbaum.

Schulze, K. G., Correll, D. Shelby, R. N., Wintersgill, M. C., & Gertner, A. (1998). A CLIPS problem solver for Newtonian physics force problems. In C. Giarratano & G. Riley (Eds.), *Expert systems principles and programming* (3rd ed. & CDROM, DOCUMENT/VIRTCONF/PAPER14/paper14pdf, pp.1-7). Boston, MA: PWS Publishing.

VanLehn, K., Niu, Z., Siler, S., & Gertner, A. (1998). Student modeling from conventional test data: A Bayesian approach without priors. In B. P. Goettle, H. M. Halff, C. L. Redfield, & V. J. Shute (Eds.), Intelligent Tutoring Systems. *4th International Conference, ITS98* (pp. 434-443). Berlin: Springer Verlag.

# THE EVOLUTION OF A BIOLOGY COURSE-RELATED WEB SITE

**Janet L. Stein Carter**
*University of Cincinnati*

## INTRODUCTION

Biologists define evolution as the series of changes that have transformed life on Earth from its beginnings until now. Similarly, the Clermont College Biology Web site (Stein Carter, 1995a) has evolved and grown since its inception in 1995. Originally consisting of a page of course descriptions, this site now contains about 400 MB of Web pages, graphics, animations, and Perl scripts which are served to several thousand visitors each day (total "hits"). These files include supplemental materials for the General Biology lecture sequence and Sophomore Ecology course, data entry capabilities for all freshman biology laboratory courses and a growing body of information for other biology courses.

The impetus for this development has been the educational needs of non-traditional students enrolled in these biology courses. As a two-year, "open access" college, Clermont accepts students that might not qualify elsewhere. The average age of Clermont's student body is around 27, and about 70% of the students are female. Many of these women, often first-generation college attendees from "urban Appalachian" backgrounds, are single mothers who also work to pay for their schooling, necessitating more flexibility on the part of faculty in dealing with legitimate absences. A number of these students have never before used a computer, yet most

realize the value of learning to do so, and while initially fearful, they are excited to learn how to use the Web.

From their inception, the Clermont Biology Web pages have also been heavily used by faculty and students at other schools and by the general public. An AltaVista search in December 1998 indicated 93 other sites with links to Clermont Biology Web pages, while a similar search in September 1999, yielded 151 such sites, 162% of the former number. As the search engines indexed these pages and e-mail arrived from around the world, it became evident that these pages were serving a use that was never envisioned and that would need to be kept in mind as the site evolved.

## INITIAL CONSTRUCTION

Initially, the idea of creating online course materials was conceived to aid employed students enrolled in evening courses. These conscientious students often notify faculty members in advance that their job or other circumstances will necessitate missing an evening of class, and frequently approach their instructors for copies of the missed lecture notes, believing that these notes should be more reliable and of greater use to them than a classmate's notes. Typically, however, instructors' teaching notes are written to serve only as reminders of points to cover, and would be ambiguous to an absent student.

In light of the above, in Summer Quarter of 1996, the decision was made to put "lecture notes" for the General Biology lecture sequence online, enabling absent students to access missed material and affording all students the opportunity to review material presented in class. Secondary goals included creating materials for in-class use and providing interested students with more information and further illustrations of the topics being discussed.

Careful consideration was given to how these lecture notes would be presented. Many of the Web-based lecture notes available at other course-related Web sites were observed to be sketchy, shorthand outlines, devoid of graphics, and often mere text files which gave the appearance of being useless to an absent student and of little use for review purposes. In contrast, full narrative form was used to present the Clermont General Biology online lecture notes. Since classroom lectures are typically supplemented by diagrams and illustrations drawn on the chalkboard, it was felt that to be intelligible and interesting to students, the online notes would also need explanatory graphics.

## STUDENT REACTION AND RESPONSE

While initially the goal was to provide notes for absent students, highly-motivated students eagerly accessed and rapidly invented their own uses for these Web pages, with many computer-phobic neophytes learning to use Netscape just to view them. Many students began reading the pages ahead of class, printing Web pages to follow in class as they took their own notes, and reviewing the pages after class to "fill in the holes" in their notes and clarify confusing areas. This unanticipated, enthusiastic reception spurred the development of additional course materials and drove the evolution of the increasing role these materials play in these courses.

In Autumn 1996, mid-way through the quarter, a student was hospitalized, then put on total bed rest for the remainder of the quarter. Normally, this would necessitate dropping a class and retaking it in the future, but because this student was able to access the online course notes from home and a friend was willing to meet with her on a regular basis to share in-class lecture notes, she was able to successfully

complete the course on schedule. This suggested the future possibility of offering the General Biology courses online.

A year later, an honors student asked to take the third quarter of the General Biology lecture sequence as an individualized study, proposing to learn the required material via the Web. This means of instruction became an interesting experiment in offering a course online. She commented that learning in this manner was only for highly self-motivated students who could set and maintain their own pace--and not having the benefit of in-class explanations made learning more difficult.

More recently, an "average" student also took the third quarter as an individualized study and also commented that she felt that the lack of verbal explanations was a drawback. Each of these students achieved the same course grade taking the third quarter online as she had achieved in the first two quarters taken in a normal classroom setting.

One concern has been the effects of the availability of these online notes on student study habits and overall performance. What has been observed, however, is that student study habits affect how students make use of these notes.

Students print the Web pages and bring them to class for use in two very different ways. Some students use printed copies for reference and clarification as they take their own notes, while other students choose to merely highlight topics and diagrams in lieu of taking their own notes. The latter miss the connection between the physical act of writing/drawing and learning, and a decline in one such student's scores as she increasingly depended on the Web pages was especially noticeable. It would appear that for students with good note-taking and study skills, use of these online lecture notes can be beneficial, while for students with poor note-taking and study skills, relying too heavily on these notes may be a detriment.

## MODIFICATION AND DEVELOPMENT

Encouraged and inspired by student interest, the General Biology Web pages have been revised, refined and updated to include even more graphics, animations, interactive games and a few surprises, thereby facilitating students' interest and understanding and enticing even the poor readers and uninvolved students to have a look. Animations, movies, and digitized videos have been included to illustrate various *processes* which cannot effectively be communicated with static graphics, and JavaScript code has been used to create interactive pseudo-animations from a series of still graphics.

Since many students are intimidated by pronunciation of biological terminology, audio pronunciations are now being included. For situations where annotated animations are advisable, presentations have been created with Corel Presentations 8®, allowing full-screen versions of these presentations to be used in class, while fully-functional smaller versions can be embedded on Web pages for students to review.

Eventually, Web pages were also added for the freshman biology laboratory classes. Since the advent of personal computers, student lab data had been collected using spreadsheets, then printed and photocopied for distribution. However, students waited in long queues to enter data into a spreadsheet only accessible from one computer. Because spreadsheets sometimes appeared confusing, students occasionally obliterated others' data or necessary formulae. There was no easy way of providing a list of acceptable options from which to choose, nor any practical way of checking the completeness and validity of the entered data.

Initially, in an attempt to solve these problems, trial data-collection Web pages were created for two of the lab experiments, from which it became clear that students

preferred Web pages over spreadsheets for data collection. HTML forms and Perl scripts were subsequently written for all freshman biology labs that required data collection.

As these lab data Web pages have been used, several advantages have become apparent. A Web page can be designed to mimic the layout of a page in a student's lab notebook, making HTML forms much more intuitive than spreadsheets. Directions can be included, drop-down lists can be used to show acceptable choices and error checking can be done before the form is submitted. Students are not confused by the presence of nor do they have direct access to everyone else's data. Simultaneous data entry from multiple computers has become possible and the inevitable slower worker can enter his/her data from the computer lab or from home.

A combination of JavaScript and Perl can be used to analyze data and can do error checking that the previous spreadsheet program couldn't do. Since the analyzed data are saved as comma-delimited text, much data can be efficiently stored in small files usable by a variety of software including most spreadsheet programs. Additional Perl scripts have also been written to read, analyze, and sort the data, then dynamically display the results as Web pages.

Nature hikes to study local flora and fauna are also significant components of Clermont's freshman biology labs. Students are tested over this material; they therefore must review, study, and learn to identify these organisms.

To facilitate recognition of the organisms, a project initiated in Spring 1997 has involved photographing endemic organisms, and putting these "on the Web" via a page which includes an interactive wildflower "quiz" and links to all photographs (Fankhauser & Stein Carter, 1997). A second application for these pictures evolved out of an unlooked-for use students made of another Web page. As part of an earlier set of pages designed to present cumulative campus ecological data, a checklist of endemic species had been created (Stein

Carter, 1995b), but freshman students quickly adopted that page as a resource for scientific names. To aid students who drew upon this page as a study tool, names of organisms were linked to photographs of those organisms, where available.

In Spring 1998, lab data entry Web pages were created for the sophomore Ecology and Evolution course, and in Spring 1999, lecture notes were added. Additionally, because the material covered in this course involved mastery of a number of mathematical concepts and calculations, a series of interactive, Web-based tutorials was created to give students practice doing these calculations. As the lab data collection Web pages for this course were created, all prior student-gathered, ecological data for the Clermont campus were compiled and Perl scripts were written to enable archival of any newly-gathered data and/or retrieval of all accumulated data.

## FUTURE GOALS AND DIRECTIONS

Growing student Web savvy could eventually change the way the General Biology lecture sequence is taught. While students claim they read the textbook before class, many say they don't understand what they read. Thus first exposure to the scheduled topics usually still occurs during lecture time. Now, students are encouraged to make use of the Web pages, but perhaps if students were *required* to also read through the online lecture notes ahead of time, more class time could be spent on answering questions and in-depth examination of related topics. Also, while many students may need the enforced structure and time frame of a classroom, offering the General Biology lecture sequence as Web-based courses could become a reality.

With a number of part-time faculty teaching lab sections, implementation of safety procedures is spotty. Also, while some instructors provide pre-lab mini-lectures to explain

key concepts and demonstrate new techniques, others merely tell the students to perform the scheduled lab exercise, often resulting in poor outcomes and/or damaged equipment. To accurately present safety information and illustrate proper lab techniques, future aspirations include having digitized videos and/or animations available on the Web for all freshman lab exercises.

## CONCLUSIONS

The Clermont College Biology Web Site has, indeed, evolved and grown from its beginning and there are plans and aspirations for even further growth and evolution. It is hoped that online syllabi and supplemental materials will eventually be available for all Clermont Biology courses. It may be possible to offer lecture courses online, if one-on-one contact between the student and faculty member can be maintained, but it is felt that while computers are useful for providing simulations and analyzing lab data, use thereof should never replace "wet" labs.

## REFERENCES

Fankhauser, D. B., & Stein Carter, J. L. (1997). *Clermont's wildflower page*. [On-line]. Available: http://BugLady.clc.uc.edu/biology/bio113/flowers.htm

Stein Carter, J. L. (1995a). *Biology at UC--Clermont College*. [On-line]. Available: http://BugLady.clc.uc.edu

Stein Carter, J. L. (1995b). *Organisms seen on Clermont College campus*. [On-line]. Available: http://BugLady.clc.uc.edu/biology/ecology/checklis.htm

# FRENCH TOPICS ONLINE:

# NATURAL ERRORS WITH VIRTUAL WINE

**Katherine Watson**
*Coastline Community College*

## INTRODUCTION

Interactivity is essential to effective language learning. Likewise, proper use of language in its natural, widely divergent contexts is critical to attainment of "communicative competence," defined by Brown (1994) and Savignon (1972), among others. A seemingly unfettered boom in education now depends upon the "four A's", as Burdeau (1997) has called them--Anyone, Anything, Any time, Any place--rather than upon the traditional "three R's". Anyone may become a student at any stage in his life and may participate in courses of any kind anywhere; education has become timeless and "distanceless".

But while this multi-modal flexibility has led to increasingly high quality in language learning and to an increased access to instruction, it has not come without some costs. That is, while incorporation of boundaryless World Wide Web links and time-unconstrained Internet connections into foreign language course content may provide interesting and "virtual visits" to faraway places, assiduous administration and technical support are vital to their usefulness as learning tools. In fact, it seems that it is not simply these links, but rather the exploitation of Multi-User Domains (MUDs), that can produce the fastest, most obvious progress in language learning, in the sociolinguistic, the semantic, and the syntactic arenas.

As Burdeau (1997) and Doheny-Farina (1996) have noted, the MUD encourages a kind of hermaphroditic language style that is characteristic neither entirely of the spoken nor of the written mode; rather, it is a combination of the two. As such, this virtual environment can free students to communicate in ways they would not normally do; likewise, it may, in the case of foreign language MUDs at least, be able to encourage production of errors in a more native-like and a less foreign-like manner. The remainder of this paper describes a study exploring the possibilities of using technology in general and MUDs in particular to enhance learning of foreign languages.

## DESCRIPTION OF THE STUDY

Thirty students have been followed through a course of five years of participation in a one-credit online course in fluency improvement in French. Students ranged in age from 16 to 86; nine men and twenty-one women were included in the study, although the course has ordinarily enrolled nearly equal numbers of men and women.

Students were asked to participate in three principal modes of electronic communication in their course: 1) electronic mail; 2) synchronous, electronic "live chat"; and 3) asynchronous threaded discussion. Electronic mail communication was to occur at least once weekly, as was asynchronous message posting; live chat sessions were open twenty-four hours a day, but the instructor was present twice a week four hours at a time. Electronic mail communication usually revolved around course "content" assignments, questions with embedded outside links demanding student response in French. Students were permitted to respond as cursorily or as completely as they wished, as long as the responses were mostly in French.

Asynchronous postings were generally made in response to a weekly question posed by the instructor, often related to current events and/or to a new Website offered for weekly perusal. Live chat sessions involved between two and thirteen discussants at any one time; topics varied widely from sports to weather to politics to art to trade to economy to language to education to cheese and Beaujolais nouveau wine, etc. E-mail was collected and saved, asynchronous messages threaded and archived and chat sessions pasted into Word files.

## FINDINGS

After at least nine weeks of regular participation in the "French Topics Online" course, learners began to demonstrate a kind of systematicity in error production that is more characteristic of native bilingual speakers of French than it is of monolingual English speakers. While surface structure and vocabulary irregularities occur, as they do quite frequently among monolingual English speakers in traditional French classes, errors in parallel verb structure and in obscure uses of the subjunctive are more typical of the online students.

For instance, while monolingual English speakers often fail to grasp the natural, logical flow in hypothetical sentences in French using the past conditional together with the pluperfect, the online students, like many unlettered French speakers, use the right hypothetical structures with verb forms that sound just like the correct ones, though they are not correct. Likewise, the online students seem to know where and how to use the subjunctive mood better than do their traditional-classroom monolingual peers.

In E-mail and asynchronous messaging, students sometimes mimic what they have seen online, either in a Web-

linked site or in their *French in Action* course materials, and because of the nature of their course questions, they add their own personal opinions. They are forced to think critically, and their naturally sophisticated modes of reasoning--adults have, after all, learned to reason and to find patterns, to apply "left-brain" skills to the analysis of the foreign--permit them to experiment with words and the structures necessary to use them correctly.

Intelligent, creative beings--adult students proceed quickly through what they call "franglais", an interlanguage structurally intermediate between French and English. Too, the onliners seem to guess less than do traditional classroom students. They tend to use what Brown (1994) has called "successful learning strategies"--and, experimenting with idiosyncratic rules of competence, produce deep-structural errors more often than surface-structure mistakes.

## CONCLUSIONS AND RECOMMENDATIONS

Further study is definitely necessary to determine what precisely is going on among foreign language learners online. As Swaffar et al. (1998) have observed, it is student progress and the influence of the computer and the electronic medium upon such progress that are at play here. If discourse skills and interactive competence are to be effectively evaluated in accordance with American Council on the Teaching of Foreign Languages (ACTFL) proficiency guidelines, Swafford (1998) suggests that the medium and technology must be separated from the message--the glass must be loosed from the wine. Indeed, it may be the case that the students who have made the greatest progress toward production of native-like French are just those who have been most assiduous, though it does appear that something more is at play.

Can it be that online learning is qualitatively different from other learning, especially among adults, because of its

dependence upon both "left-brain" skills and "right-brain" ones, for instance? Can it be that the nature of the Internet requires the kind of "field dependence" characterizing the artistic mind as well as the sort of "field independence" that defines the adult engineer? Can it be that real language learning, ability to combine the social and the syntactic, the semantic and the sensitive, is benefited by virtual communication? Much more data must be collected and analyzed if such questions are to receive a satisfactory, satisfying response.

## REFERENCES

Brown, H.D. (1994). *Principles of language learning and teaching.* Englewood Cliffs, NJ: Prentice-Hall Regents.

Burdeau, I. (1997). *Virtual classrooms, virtual schools.* Unpublished Master's dissertation, University of Brighton, England.

Doheny-Farina, S. (1996). *The wired neighborhood.* New Haven: Yale University Press.

Savignon, S. (1972). *Communicative competence: An experiment for language teaching.* Philadelphia: The Center for Curriculum Development.

Swaffar, J., Romano, S., Markley, P., & Arens, K. (1998). *Language learning online: Theory and practice in the ESL and L2 computer classroom.* Austin: Labyrinth Publications, the Daedalus Group.

## CONTRIBUTORS

**Michel Aubé**
Professeur, Faculté d'éducation
*Université de Sherbrooke*
2500 Boulevard Université
Sherbrooke, Quebec J1K 2R1
Canada
Tel: 819-821-8000 ext. 2426
Fax: 819-821-7950
E-mail: maube@courrier.usherb.ca

**J. Wesley Baker**
Professor, Communication Arts
*Cedarville College*
P O Box 601
Cedarville, OH 45314-0601
Tel: 937-766-7967
Fax: 937-766-2760
E-mail: bakerw@ cedarville.edu

**Martin Barber**
School of Business Studies
*University of Salford*
Salford, Greater Manchester M5 4WT, UK
Tel: 011-44-161-295-3576



177

**Elizabeth Berry**
Computer Science
*California State University, Northridge*
18111 Nordoff Street
Northridge, CA 91330-8281
Fax: 818-677-7208

**C. J. Birch**
Director, Management
*Staffordshire University*
Lichfield Centre
The Friary
Lichfield W513 G0G, UK
Tel: 011-44-121-747-5147
Fax: 011-44-1543-301-112
E-mail: birchcj@aol.com

**Ed Boyapati**
*RMIT University*
C&ME, 124 La Trobe St
Melbourne VIC 3000, Australia
Tel: 011-61-3-9925-3692
Fax: 011-61-3-9925-3746
E-mail: ed@rmit.edu.au

**Kris Bulcroft**
Center for Instructional Innovation
*Western Washington University*
Mail Stop 9094
Bellingham, WA 98225
Tel: 360-650-3004
Fax: 360-650-2816
E-mail: Kris.Bulcroft@wwu.edu

**David Byres**
Professor, Biology
*Florida Community College at Jacksonville*
11901 Beach Blvd.
Jacksonville, FL 32246
Tel: 904-646-2038
Fax: 904-646-2209
E-mail: dbyres@fccj.org

**Joyce A. Carter**
Academic Assistance Programs
*Central Michigan University*
Foust Hall 150
Mount Pleasant, MI 48859
Tel: 517-774-3465
Fax: 517-772-1291
E-mail: Joyce.A.Carter@cmich.edu

**Karen Casto**
Center for Instructional Innovation
*Western Washington University*
Mail Stop 9094
Bellingham, WA 98225
Tel: 360-650-4943
Fax: 360-650-2816
E-mail: Karen.Casto@wwu.edu

**Jack A. Chambers**
Int. Director
Assessment & Certification Centers
*Florida Community College at Jacksonville*
601 W. State Street
Jacksonville, FL 32202
Tel: 904-632-3231
Fax: 904-633-8445
E-mail: jchamber@fccj.org

**Michael Christie**
Centre for Academic Development
*Chalmers University of Technology*
86 Eklandagatan
Göteborg 412 96
Sweden
Tel: 011-46-31-772-8556
Fax: 011-46-31-772-2578
E-mail: Michael.Christie@pedu.chalmers.se

**Daniel J. Doyle**
Professor, History
*Pennsylvania College of Technology*
One College Avenue
Williamsport, PA 17701
Tel: 570-326-3761
Fax: 570-321-5559
E-mail: ddoyle@pct.edu

**Richard Farr**
Department of Manufacturing Engineering
and Operations Management
*University of Nottingham*
University Park
Nottingham NG7 2RD, UK

**Charles Graessle**
Social Sciences
*Olivet College*
Olivet, MI 49076
Tel: 616-781-9362
Fax: 616-749-7695
E-mail: cgraessle@olivetnet.edu

**Barclay M. Hudson**
Organizational Design and Effectiveness
*Fielding Institute*
460 17th Street
Santa Monica, CA 90402
Tel: 310-393-5436
Fax: 310-393-4620
E-mail: bhudson@fielding.edu

**William J. Joel**
Mathematics and Computer Science
*Western Connecticut State University*
181 White Street
Danbury, CT 06810
Tel: 203-837-9353
Fax: 203-837-8276
E-mail: joelw@wcsu.ctstateu.edu

**David A. Lake**
Physical Therapy
*Armstrong Atlantic State University*
11935 Abercorn Street
Savannah, GA 31419
Tel: 912-921-2327
Fax: 912-921-5838
E-mail: lakedavi@mail.armstrong.edu

**Robert Lingard**
Computer Science
*California State University, Northridge*
18111 Nordoff Street
Northridge, CA 91330-8281
Tel: 818-677-3825
Fax: 818-677-7208
E-mail: rlingard@ecs.csun.edu

**Pam Northrup**
Chair, Technology, Research and Development
*University of West Florida*
11000 University Pkwy
Pensacola, FL 32514
Tel: 850-474-3255
Fax: 850-474-2804
E-mail: pnorthru@uwf.edu

**Michael R. Pinter**
Mathematics and Computer Science
*Belmont University*
1900 Belmont Blvd.
Nashville, TN 37212
Tel: 615-460-6207
Fax: 615-460-5458
E-mail: pinterm@mail.belmont.edu

**K. G. Schulze**
Computer Science Dept.
*United States Naval Academy*
572 Holloway Road
Annapolis, MD 21402
Tel: 410-293-6821
Fax: 410-293-2686
E-mail: schulze@usna.edu

**R. N. Shelby**
Physics Dept.
*United States Naval Academy*
572 Holloway Road
Annapolis, MD 21402
Tel: 410-293-6689
Fax: 410-293-3729
E-mail: shelby@usna.edu

**Janet L. Stein Carter**
Science, Math & Engineering
*Clermont College (University of Cincinnati)*
4200 College Dr
Clermont OH 45103
Tel: 513-732-5313
Fax: 513-732-5304
E-mail: Janet.Carter@uc.edu

**D. J. Treacy**
Physics Dept.
*United States Naval Academy*
572 Holloway Road
Annapolis, MD 21402
Tel: 410-293-6651
Fax: 410-293-3729
E-mail: treacy@usna.edu

**Katherine Watson**
International Languages
*Coastline Community College*
11460 Warner Avenue
Fountain Valley, CA 92708
Tel: 714-505-4699
Fax: 714-241-6287
E-mail: bizarrerie@aol.com

**M. C. Wintersgill**
Physics Dept.
*United States Naval Academy*
572 Holloway Road
Annapolis, MD 21402
Tel: 410-293-5508
Fax: 410-293-3729
E-mail: mwinter@usna.edu